WHALE-WATCHING IN JUNEAU, AK: ASSESSING POTENTIAL EFFECTS ON HUMPBACK WHALES AND UNDERSTANDING PASSENGER PERCEPTIONS

By

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Abstract

The feeding grounds of the North Pacific humpback whale (*Megaptera novaeangliae*) in Juneau, Alaska have rapidly developed into a popular whale watch destination during the summer (May-September). The whale watch industry has tripled in size in the last 18 years, currently numbering approximately 65 vessels. The sustainability of this industry could be jeopardized if the health and dependability of the resource, the whales, is negatively affected by increasing vessel pressure. The aim of this project is to provide a holistic understanding of whale watch tourism in Juneau by assessing 1) humpback whale responses to whale-watching vessels and 2) passenger experiences as a conduit for conservation of whales and the environment. Data were obtained during 2016 and 2017, comprising observations of 201 humpback whale groups and collection of 2331 passenger surveys. To address the first objective, shore-based measurements and observations of humpback whales were conducted to assess potential impacts of whale-watching vessels on short-term movement and behavioral patterns of whales. Linear mixed effects models indicated that the presence (vs. absence) of vessels was related to significantly higher deviation in linear movement, increased swimming speed, and shorter inter-breath intervals (IBI). For each additional vessel present, deviation increased and IBI significantly decreased. Linear regression models also indicated that as time spent in the presence of vessels increased, respiration rate (breaths per minute) increased. Markov chain analyses indicated that feeding and traveling humpback whales were likely to maintain their behavioral state regardless of vessel presence, while surface active humpback whales were likely to transition to traveling in the presence of vessels. To address the second objective, surveys were administered to passengers before, immediately after, and six months after a whale-watching tour to measure knowledge, intentions, behaviors, and attitudes over time. Following a whale-watching tour, awareness of whale-watching guidelines/regulations doubled and support for guidelines/regulations significantly increased and remained high six months later. Binomial logistic regression models determined that strong support for guidelines/regulations was more likely if participants were aware of guidelines/regulations and less likely if participants disagreed that vessels have a negative impact on whales. Lastly, linear regression models revealed that participants that acknowledged human impacts on whales and their habitat had stronger pro-environmental attitudes. As vessel presence increases in this region, adherence to whale watching guidelines/regulations is likely to become increasingly important to mitigate cumulative effects that may arise from short-term changes in whale behavior in a changing environment. It is recommended that management revisit the current measures in place to better suit the industry today, and that education during whale watching tours be included as a potential management tool to encourage operator compliance. The results presented in this thesis indicate that both management and the industry itself can help to develop a mutually beneficial industry for the whale watching operators, the whales, and the people that come to watch them.

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General Introduction

Overview

Over the last century, whales have transitioned from an economic commodity extracted from the ocean to a resource highly prized for their existential value in the ocean. Following the severe reduction of many whale populations globally from commercial whaling, many whale populations have begun rebounding and repopulating their former ranges (Best, 1993; Hoyt and Parsons, 2014). The presence of whales has allowed many coastal communities to introduce whale watching as a tourism activity. The last estimate of global annual revenue for whale watching was $2.1 billion in 2009 (O'Connor et al., 2009), indicating that whales can bring great value being alive. This transition from whaling to whale watching has led the industry to be thought of as a non-consumptive form of tourism. However, as the industry has grown in size, it risks exploiting the whale populations upon which it depends.

In order to be considered as "ecotourism" the tourism activity should be designed to benefit natural areas directly or indirectly through sustainable use of resources, increasing conservation value in local communities and promoting pro-environmental attitudes and responsible environmental behaviors in participants (Beaumont, 2001). Whale watching has the potential to fall under this category of tourism. For example, following a whale watching tour, passengers have demonstrated increases in knowledge about cetaceans (Mayes and Richins, 2009; Filby et al., 2015), awareness of threats to cetaceans (Finkler and Higham, 2004; Filby et al., 2015), pro-environmental attitudes (Christensen et al., 2007), and support for conservation of whales and marine environments (Christensen et al., 2009). However, critics suggest that most whale-watching operations would not fall under the classification of "ecotourism" (Hoyt and Parsons, 2014) and increased use of natural areas and resources can be just as damaging as other forms of mass tourism (Beaumont, 2001).

The growth and success of whale watching industries globally has attracted a more general or "mass" tourist (Duffus and Dearden, 1990). Compared to specialist tourists, who often visit an area with prior knowledge and concern for conservation and environmental issues, general tourists may have different expectations and motivations for the experience (Duffus and Dearden, 1990; Rawles and Parsons, 2005). General tourists may be less environmentally motivated and be less understanding of cetacean behavior (Hoyt and Parsons, 2014). Instead, the general tourist expectations may be influenced by media footage or whale-watching marketing materials showing pictures or videos of close encounters with cetaceans (Hoyt and Parsons, 2014). Similarly, previous experiences at captive cetacean facilities with whales or dolphins may set the expectation of whales "showing off" or performing for them. Therefore, tourists are increasingly demanding more encounter-driven trips that are action-packed (Hoyt and Parsons, 2014). Developing and managing an ecologically responsible whale-watching industry can be increasingly difficult as operators feel pressured to obtain close encounters to satisfy their customers (Orams, 2000).

Whale watching vessel presence has the potential to disrupt whale behavior and elicit evasive responses by whales. Short-term behavioral responses to whale watching vessel presence includes vertical changes indicated by alterations in diving and foraging patterns (Stamation et al., 2010; Christiansen et al., 2013) as well as horizontal changes such as increased in swimming speed and direction (Scheidat et al., 2004). If more time and energy is spent avoiding vessels, rather than in behaviors essential for body maintenance (i.e. foraging and resting), decreased physical fitness can result in long term health consequences (Lusseau and Bejder, 2007; Parsons, 2012). If effects are severe enough, population consequences could result from declines in reproduction rate and survival (Bejder et al., 2006a; Parsons, 2012; New et al., 2015). Whales may also avoid whale watching vessel presence altogether by altering habitat use and distribution (Bejder et al., 2006b; Cartwright et al., 2012).

Geography of a region and the size of the industry can also affect whale populations differently. Whale watching along extended coastlines (e.g., California, North Atlantic), allow the few operators in each port to spread out over a large area. By contrast, geographically confined areas, like Washington State's inland waters, have operators from many different ports congregating in the same area to watch more concentrated whale populations (Duffus and Dearden, 1993; Lusseau et al., 2009). Therefore, it is important to consider cumulative exposure of vessels on individual whales.

In the United States, regulations and guidelines pertaining to whale watching vary by both region and species (Carlson, 2010). The Marine Mammal Protection Act (MMPA) prohibits "take" of all marine mammals, defined as to "harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal". The Endangered Species Act (ESA) further protects species which are considered endangered or threatened throughout all or a significant portion of their range. With these protections in mind, marine mammal viewing regulations and guidelines are developed by National Oceanic and Atmospheric Administration (NOAA) Fisheries regional offices to meet the specific needs of the region and the species. Distance thresholds are the most frequently used management measure. For example, federal regulations require that no vessel approach within 500 yards of critically endangered North Atlantic right whales (*Eubalaena glacialis*), within 200-yards of endangered resident killer whales (*Orcinus orca*) in Washington State's inland waters (National Oceanic and Atmospheric Administration, 2011), and within 100 yards from humpback whales (*Megaptera novaeangliae*) in Hawaii and Alaska waters.

Monitoring for compliance and enforcing regulations can be challenging for management due to remoteness of whale watching activities or lack of resources available to enforcement (Kessler and Harcourt, 2013; Filby et al., 2015). Other strategies to protect marine mammals include voluntary viewing guidelines and codes of conducts. Often government organizations and nonprofits create educational programs that issue recommended guidelines for distance thresholds and vessel operation. However, since ethical obligation and peer pressure largely drive compliance of these voluntary measures, a lack of understanding or ownership can cause inconsistences in compliance between operators and the guidelines each operator chooses to follow (Garrod and Fennel, 2004; Allen et al., 2007; Wiley et al., 2008; Walker, 2010).

The whale watching industry in Juneau, Alaska has reflected the growth seen in many other regions of the world. During the summer months, the industry focuses on primarily humpback whales, with opportunistic sightings of killer whales. This thesis is a case study of the whale watching industry in Juneau to understand how the presence of vessels is affecting humpback whales in the short-term and its potential for conservation benefits. With this information, the industry and management can work towards creating a mutually beneficial industry for the tour operators, local communities, whales, and the coastal ecosystems upon which all of these entities depend.

Whale Watch Tourism in Juneau, Alaska

The city of Juneau is home to approximately 32,000 residents and is located within Southeast Alaska's Inside Passage (United States Census Bureau, 2018). The tourism industry is important for this region, generating $657 million in visitor spending and providing 17% of regional employment in 2016 (Rain Coast Data, 2018). As a city only accessible by boat or by plane, 93% of Juneau's visitor industry derives from cruise ship tourism between the months of April and October (McDowell Group, 2017). The cruise ship industry is burgeoning in Southeast Alaska, with a 55% increase in the number of tourists expected from 2010 to 2019 (Rain Coast Data, 2018). With 99% of cruise ship itineraries including Juneau as a port-of-call, the city will see the majority of the 1.36 million visitors in 2019. Whale watching and other day cruises have become one of the most popular activities, attracting approximately one-third of all tourists (McDowell Group, 2017).

Juneau has become a premiere whale watching destination in the United States (O'Connor et al., 2009). The whale watching industry in Juneau is largely dependent on North Pacific humpback whales. The humpback whale population in the North Pacific has grown at approximately 7% per year (Muto et al., 2017) with an estimated 1,585 individuals in Southeast Alaska in 2008 (Hendrix et al., 2012). These whales reliably occur from May to September when they return from low latitude breeding grounds to forage on abundant prey resources (Baker et al., 1986). Within the feeding grounds exist an abundance of euphausiids (krill) and a variety of small schooling fish including herring (*Clupea pallasi)*, capelin (*Mallotus villosus*) and sand lance (*Ammodytes hexapterus*) (Krieger and Wing, 1984; 1986). Consuming large amounts of prey allows humpback whales the opportunity to obtain the nutrients and energy essential for body maintenance and preparation for migration to low-latitude breeding grounds where humpback whales fast due to limited prey availability (Irvine et al., 2017). This productive area also provides whale watchers the opportunity to view other wildlife such as killer whales, Dall's porpoise (*Phocoenoides dalli*), harbor porpoise (*Phocoena phocoena*), Steller sea lions (*Eumetopias jubatus*), and harbor seals (*Phoca vitulina*).

The number of dedicated whale watching vessels has tripled over the last 15 years, from an estimated 20 vessels in 2001 (Peterson, 2001), to 65 in 2015 (Di Clemente et al., 2018). Vessels range in size from 8 m to 24 m and accommodate between 4 to 149 passengers. Nearly all of the whale watching boats will leave from Auke Bay Harbor, with tours taking place as early as 7am to as late as 9pm and lasting from 2 to 4 hours in length. Tours take place in a relatively small area, approximately 30 x 15 kilometers, within an archipelago of islands and narrow passageways (Teerlink et al., 2018). At any point during the summer months there can be between two and 30 whales foraging in the tour area, gathered in areas were prey is likely to be abundant. This consistency of whale presence has led operators to offer a "whale sighting guarantee" or your money back. The varied distribution and number of whales throughout a season, combined with the pressure for obtaining a whale sighting, can influence the number of vessels watching an individual or group at any given time. For this reason, it is possible to have as many as 30 vessels following a single group of whales (Teerlink et al., 2018).

While NOAA federal regulations for humpback whales limit approach distances to 100 yards and urge cautious maneuvers, there are no limits or regulations on the number of vessels that may view a whale or group at one time, or on the size or growth of the industry. A voluntary stewardship and recognition program, Whale SENSE, was introduced to Juneau in 2015 by the National Marine Fisheries Service (NMFS) in partnership with the Whale and Dolphin Conservation (WDC) (NOAA Fisheries and Whale and Dolphin Conservation, 2018) to support existing regulations and guidelines. This program encourages responsible practices by recognizing operators for following best practices. Operators in the Whale SENSE (acronym defined below) program agree to Stick to the regional whale-watching guidelines, Educate naturalists, captains, and passengers to have SENSE while watching whales, Notify appropriate networks of whales in distress, Set an example for other boaters, and Encourage ocean stewardship. In return, they receive recognition for practicing responsible practices on the program's website[1] and can promote their company with the eco-label. In 2018, seven companies in Juneau participated in the Whale SENSE program, comprising approximately 67% of vessels in the industry.

Thesis Goals

This thesis focuses on whale watching and its effects on humpback whales and the people who watch them in Juneau, AK. Chapter 1 discusses the potential short-term effects of whale watching vessel presence on humpback whales on a feeding ground. Humpback whale movements and behavior were examined by collecting shore-based observations using a theodolite to determine if differences according to vessel presence, number of vessels present, and time spent with vessels could be detected, and to determine how humpback whale behavioral states were affected by vessel presence. Chapter 2 investigates whether whale watching serves as a potential conduit for conservation of whales and the environment. Passengers were surveyed before, immediately after, and 6 months after a whale-watching tour to determine changes in knowledge, intentions, behaviors, and attitudes. The overall objective of this thesis is to provide a holistic view of the whale watching industry in Juneau, to ultimately contribute towards ensuring a sustainable industry through the development of conservation policies and promotion of whale watching best practices.

[1] https://www.whalesense.org

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Chapter 1: Humpback whale movements and behavior in response to whale watching vessels in Juneau, AK[2]

Abstract

The whale watching industry in Juneau, Alaska relies primarily on the presence of North Pacific humpback whales (*Megaptera novaeangliae*). To meet demands from the rapidly growing tourism industry, the number of whale watching vessels in this region has tripled over the last 18 years. As a result, increased vessel presence could have negative effects on humpback whales, ranging from short-term behavioral disturbance to long-term impacts. The current humpback whale viewing regulations may be outdated and not as effective as when they were established 18 years ago, when both the whale watching industry and humpback whale population were smaller. The present study assessed how humpback whale movement and behavioral patterns were affected by (1) vessel presence and number of vessels present, and (2) time spent in the presence of vessels, and (3) determined how humpback whale behavioral state transitions were affected by vessel presence. A total of 201 humpback whale focal follows were conducted during summer 2016 and 2017. Based on linear mixed effects models, whales in the presence (vs. absence) of vessels exhibited 38.9% higher deviation in linear movement ($p = 0.001$), 6.2% increase in swimming speed ($p = 0.047$) and a 6.7% decrease in inter-breath intervals (IBI) ($p = 0.025$). For each additional vessel present, deviation increased by 6.2% ($p = 0.022$) and IBI decreased by 3.4% ($p = 0.001$). As time spent in the presence of vessels increased, respiration rate increased ($p = 0.011$). Feeding and traveling humpback whales were likely to maintain their behavioral state regardless of vessel presence, while surface active humpback whales were likely to transition to traveling in the presence of vessels. These short-term changes in movement and behavior in response to whale watching vessels could lead to cumulative, long-term consequences, negatively impacting the health and

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predictability of the resource on which the industry relies. Current formal approach regulations and voluntary guidelines should be revisited to reduce vessel pressure and mitigate any potential negative effects of this growing whale watching industry.

1. Introduction

Whale watching has been the world's fastest growing wildlife-based activity since its inception 1950's (Hoyt and Parsons, 2014). Global whale watching tourism opportunities have grown concomitantly with the recovery of many whale populations from historic whaling pressure (Best, 1993; O'Connor et al., 2009). More than 13 million people in 119 countries engaged in whale watching activities in 2008, yielding a global annual economic value of $2.1 billion and $1 billion in revenue in the U.S. alone (O'Connor et al., 2009). As a non-consumptive use of cetaceans, whale watching is often labeled as "eco-friendly", "green" or "sustainable" tourism. However, as the industry grows globally and the number of human-whale interactions increases, the whale watching industry could be exploiting the resource on which they rely (Parsons, 2012; Cressey, 2014).

There is mounting evidence that whale watching can lead to negative effects ranging from short-term behavioral changes that disrupt life functions (e.g., feeding) to long-term consequences such as declines in physical fitness and habitat alteration (Lusseau and Bejder, 2007). In the presence of whale watching vessels, whales have exhibited short-term behavioral changes including alteration of swimming speed and direction (Scheidat et al., 2004), diving and foraging patterns (Stamation et al., 2010; Christiansen et al., 2013a), aerial behaviors (Stamation et al., 2010; Di Clemente et al., 2018), resting patterns (Lusseau, 2003; Lundquist et al., 2012; Steckenreuter et al., 2012), group size and cohesion (Steckenreuter et al., 2012), and acoustic communication (Sousa-Lima and Clark, 2008). If short-term avoidance behaviors by whales (e.g., traveling at higher speeds, frequent changes in direction, movement away from whale watching vessels) negatively affects body maintenance behaviors such as foraging and resting, there could be long-term declines in vital rates (Lusseau and Bejder, 2007; Parsons, 2012). If whale watching vessels are repeatedly perceived as a threat, hormonal responses leading to chronic stress can suppress growth and limit reproduction (Atkinson et al., 2015). For females, reduction in time spent foraging could compromise energetic budgets required to produce and raise a calf, resulting in population decline (Bejder et al., 2006a; Parsons, 2012; New et al., 2015). Over time, whales may also alter habitat use and distribution in response to whale watching vessel presence (Bejder et al., 2006b; Cartwright et al., 2012).

To mitigate the potential negative consequences of disturbance from whale watching vessels, guidelines and regulations have been established for commercial whale watching operations in over 50 countries (Carlson, 2010). In the United States, all cetaceans are protected under the Marine Mammal Protection Act of 1972 (MMPA), and endangered cetaceans are further protected under the Endangered Species Act of 1973 (ESA). In accordance with the MMPA, the National Oceanic and Atmospheric Administration (NOAA) has established formal whale watching regulations and voluntary guidelines aimed to protect marine mammals from injury and behavioral disturbance. Each NOAA Fisheries Regional Office has developed marine mammal viewing regulations and guidelines tailored to the specific needs of the region. In U.S. Atlantic and Alaska regions NOAA and the Whale and Dolphin Conservation sponsor Whale SENSE (NOAA Fisheries and Whale and Dolphin Conservation, 2018), a voluntary conservation and stewardship program that recognizes participating commercial whale watching operators. Participating tour companies complete training, undergo evaluation, and agree to follow regional whale watching guidelines.

Humpback whales (*Megaptera novaeangliae*) exist in every major ocean basin (Muto et al., 2018) and are a popular focal point of many whale watching tours (O'Connor et al., 2009). Southeast Alaska is a productive feeding ground for the Central North Pacific humpback whale stock, designated as "depleted" by the MMPA (Muto et al., 2018). The ESA further categorizes stocks into Distinct Population Segments (DPS) based on their breeding areas. In Southeast Alaska, 94% of humpback whales belong to the Hawaii DPS (Calambokidis et al., 2001; Baker et al., 2013; NMFS Alaska Region, 2016) and 6% belong to the Mexico DPS (Muto et al., 2017). In 2016, the Hawaii DPS was delisted and designated as "not at risk" under the ESA, while the Mexico DPS was listed as "threatened" (National

Oceanic and Atmospheric Administration, 2016). Overall, the humpback whale population in the North Pacific has grown at approximately 7% per year (Muto et al., 2017) with an estimated 1,585 individuals in Southeast Alaska in 2008 (Hendrix et al., 2012). Humpback whales migrate to Southeast Alaska from low latitude breeding grounds and are reliably present from May to September (Baker et al., 1986). Acquiring nutrients and energy on the feeding grounds is essential for body maintenance and preparation for migration to low-latitude breeding grounds where humpback whales fast due to limited prey availability (Irvine et al., 2017).

Whale watching has become a lucrative industry and an important source of income to many Southeast Alaska coastal communities, with an estimated annual value of $32 million in the city of Juneau alone (O'Connor et al., 2009). To meet the demand of the rapid growth of tourism in Juneau, the whale watching industry has tripled since 2000. Currently, there are approximately 65 vessels that offer dedicated whale watching tours, in addition to fishing charter vessels which view whales opportunistically (Di Clemente et al., 2018). Due to this surge in vessel presence, it is unclear if the current Alaska whale watching regulations, established in 2001 (Table 1.1), are sufficient to mitigate potential disturbance to humpback whales. When the present study took place, NOAA regulations required that vessels: 1) 'not approach within 100 yards of a humpback whale'; 2) 'not place your vessel in the path of oncoming humpback whales causing them to surface within 100 yards of your vessel'; and 3) 'operate your vessel at a slow, safe speed when near a humpback whale', and 4) 'not disrupt the normal behavior or prior activity of a whale' (National Oceanic and Atmospheric Administration, 2016).

Crowding of whales is of particular concern in the Juneau whale watching area due to complex geography consisting of narrow channels and obstructed waterways (Weingartner et al., 2009). Compared to other whale watching locations (e.g., Stellwagen Bank, Hawaiian Islands) characterized by open waters for viewing humpback whales, opportunities for vessel dispersion in Southeast Alaska are limited. Throughout the summer, humpback whales vary in number and distribution throughout the region, which influences the number of vessels watching an individual or group at any given time. For example, bubble net feeding groups (i.e., highly conspicuous, and cooperative surface-feeding groups that release underwater bubble streams to corral schools of Pacific herring towards the surface (Sharpe, 2001)), can attract as many as 30 vessels (Teerlink, 2017) at once. Furthermore, the long daylight hours during the Alaskan summer allows whale watching vessels to operate for extended periods from 7:00am to 9:00pm. As a result, whales may be exposed to whale watching vessels for the majority of the 24-h cycle. The sustainability of the Juneau whale watching industry will likely have far-reaching and long-term ecological and economic effects throughout Southeast Alaska as some of the same humpback whales travel between Juneau and other popular tourist communities such as Ketchikan, Sitka, Hoonah, Skagway, and Glacier Bay (Hendrix et al., 2012).

In order to ensure that proper mitigation measures are in place to protect the resource upon which the industry relies, the goal of the present study was to assess the effects of whale watching vessels on humpback whales in Juneau, Alaska. The objectives were to determine how humpback whale movement and behavioral patterns are affected by (1) vessel presence and the number of vessels present and (2) time spent in the presence of vessels, and to assess the effect of (3) vessel presence on humpback whale behavioral state transitions.

2. Methods

2.1 Data collection

Land based observations occurred at Point Lena (58.39140 N, 134.77495 W) and Point Retreat (58.41308 N, 134.95644 W) (Figure 1.1). Data were collected using a Sokkia DT-5A theodolite connected to a laptop computer using the data acquisition software, *Mysticetus*[3]. Data collection required a team of at least 3 people, consisting of a theodolite operator, computer operator, and 1-2 spotters. Humpback whales were observed using a Konus 20x60 spotting scope and Leica 10x42 binoculars. Behavioral events and states were classified using an ethogram (Table 1.2). During each field day, environmental variables, including visibility, cloud cover, precipitation, and Beaufort sea state, were

[3] https://mysticetus.com/

collected every hour or as conditions changed. Due to daily tidal fluctuations of up to 5 m, theodolite station height was measured approximately every 15 min using vertical markers on the shoreline. To ensure reliable data collection, observations were made only in Beaufort sea state of ≤ 3, little or no rain, and < 15 kt wind.

Humpback whale movement and behavioral data with respect to whale watching vessel presence were collected using theodolite tracking methods described in Würsig et al. (1991) and behavioral observation methods described in Di Clemente et al. (2018). A “sighting” (i.e., observation period of behaviors for a humpback whale) began when an individual was spotted < 5 km from the field site. Focal follow observations with all-occurrence sampling (Altmann, 1974) was used to record behavioral events (Table 1.2) and continuous sampling was used to record behavioral state, heading, and number of vessels present within a 500 m radius of the whale at the time of the behavioral event. A 500 m threshold was used previously by Di Clemente et al. (2018) as an intermediate distance between distance thresholds previously used in whale-watching studies on humpback whales (300 m (Corkeron, 1995; Morete et al., 2007) and 1000m (Gulesserian et al., 2011; Schaffar et al., 2013)). Vessels were considered present when within 500 m of the whale and observed approaching, departing, or tracking (i.e., following a whale in a straight line or in a parallel line according to the last heading observed of the whale). Simultaneously, the theodolite was used to obtain successive latitude/longitude coordinates of humpback whale positions, which were plotted as polyline tracks on *Mysticetus*. A “track” of the individual included all positions recorded along with time, distance from field site, and number of vessels within 500 m. Distinct physical markings (e.g., unique coloration, scarring, fluke notching, or dorsal fin shape) were recorded throughout the observation to aid in confirming the focal animal. Groups > 1 whale were not included in the dataset because the focal animal could not be reliably determined throughout the follow.

No limit was set for the duration of sightings or tracks. The mean dive time for humpback whales in Southeast Alaska is < 10 min (Dolphin, 1987), therefore a sighting ceased once an individual went undetected for > 20 min or had been absent from study area > 10 min. An individual was considered “absent” if it was out of range (i.e., > 5 km from the theodolite and verified on *Mysticetus)* or out of sight due to trees or presence of islands. This distance has been recommended for stations between 20 m and 45 m above mean low sea level to reduce errors in precision from targets at greater distances (Würsig et al., 1991; Piwetz et al., 2018). This method was similarly used by Di Clemente et al. (2018) to minimize the chance of sampling an individual that was different from the original focal animal.

2.2 Variables

2.2.1 Movement

2.2.1.1 Movement metrics

Successive positions of a humpback whale were used to obtain deviation, speed, and directionality and used to calculate changes in movement (Würsig et al., 1991). Deviation is the relative turning angle between 3 consecutive positions (Christiansen et al., 2013a). Deviation indicates path predictability for each position in the track by estimating the angle between the path taken and the straight-line path predicted (Williams et al., 2002; Christiansen et al., 2013a). Deviation ranges between 0° (linear movement) and 180° (erratic movement) (Christiansen et al., 2013a). Speed (kph) was the distance travelled between two coordinates divided by the time interval between those two coordinates (Lundquist et al., 2012). Directionality measured the linearity of movement of each surfacing in the track, calculated by dividing the distance between the end-point of the specific section of the track by the actual distance of the track line of the section (Christiansen et al., 2013a). Directionality ranged between 0 (circular movement) and 1 (linear movement) (Christiansen et al., 2013a). Microsoft Excel (2016) was used to conduct calculations of deviation, speed, and directionality using data points recorded on *Mysticetus*.

2.2.2 Behavior

2.2.2.1 Behavioral metrics

Inter-breath interval (IBI) and respiration rate (RESP) were used to measure behavioral changes. Humpback whale IBIs were estimated as the time elapsed between two consecutive blows (Christiansen et al., 2013a). A fluke-up dive was typically associated with a longer IBI, therefore "Dive Type" for each interval was identified as "No fluke" or "Fluke-Up". RESP (blows/min) was calculated by dividing the number of blows observed during a sighting by the total duration of the sighting.

2.2.2.2 Behavioral state transitions

Each behavioral event was categorized into one of four behavioral states (Table 1.2): feeding (FED), resting (RES), surface active behavior (SAB), and traveling (TRA). Over the course of a sighting, the behavioral states comprised a whale's behavioral budgets (i.e., the proportion of time an animal spends in different behavioral states (Christiansen et al., 2013b)). A change in behavioral state during a sighting was considered a behavioral transition. Each behavioral transition was categorized into 'presence' situations (i.e., observations in which ≥ 1 vessels were present < 500 m of the focal whale) and 'absence' situations (i.e., observations in which no vessel was present < 500 m radius of the focal whale).

2.3 Statistical methods

2.3.1 Presence and number of whale watching vessels (Obj. 1)

Regression analyses were performed using the open-source software R v.3.4.3 (R Core Team, 2018). To assess the significance of whale watching vessels in explaining variations in deviation, speed, and IBI, linear mixed effects models (LMM) were fit by restricted maximum likelihood using the lme function in the R package nlme (Pinheiro et al., 2018). Covariates considered for the "base model" included behavioral state, location, time of day (indicated as a percentile of daylight hours, where sunrise = 0 and sunset = 1), Julian date, year, and environmental variables (i.e., visibility, Beaufort sea state) as fixed effects. Sighting distance associated with fixes (i.e., individual data records collected in *Mysticetus*) were included as an explanatory variable for deviation and speed analysis to account for potential vertical angle measurement errors associated with larger distances from shore. Time between fixes was included for deviation and dive type was included for IBI analysis to account for variability in direction changes and breathing intervals associated with longer dive times. Stepwise model selection based on the corrected Akaike Information Criterion (AICc) was used to select the combination of covariates that best explained the variations in each metric. As humpback whales may exhibit individually-specific behaviors (Peterson, 2001), whale ID was included in each model as a random effect (intercept) to account for variability in mean deviation, speed, or IBI among individual whales. Two individuals (IDs 1538 and 1839 from the Alaska catalog) were seen frequently in the study area and could be readily identified based on their distinctive pigmentation on the underside of their flukes and dorsal fin shape. All observations of these identifiable individuals (i.e., 1538 and 1839) were included under the same unique identification numbers.

For each metric, a series of alternative models were used to test the possible effects of whale watching vessels. The first model included vessel presence (vessels = 0 vs. vessels > 0) as a fixed effect to compare whale movement and behavior when vessels were present to those in which vessels were absent. The second model included the number of vessels as a linear fixed effect to understand how increasing numbers of vessels may influence movement and behavior. The third model included a categorical variable for the number of vessels to examine results for possible non-linearities and threshold effects. For deviation and speed, spatial autocorrelation was accounted for since measurements closer in space were likely to be more similar than those farther apart. For IBI, temporal autocorrelation was accounted for by including a first-order autoregressive term to model the possible dependence between consecutive residuals as $\varepsilon_t = \phi * \varepsilon_{t-1} + \nu_t$, where ϕ is the first-order auto-regressive coefficient and the errors (innovations ν_t) are assumed to follow a Gaussian distribution. Errors (ν_t) were examined for normality and homoscedasticity. The AICc was used to select the best-fit model while maintaining model parsimony.

2.3.2 Percent time with vessels (Obj. 2)

The percent time spent with vessels (PERC) was calculated by taking the sum of intervals spent in the presence of vessels and dividing it by the total length of the track or sighting. Linear regression was used to test for possible effects of PERC on directionality and RESP, while controlling for overall behavioral state (i.e., traveling, feeding, resting, surface active, and mixed), Julian date, year, location, and duration of track or sighting.

2.3.3 Behavioral state transitions (Obj. 3)

To examine changes in whale activity budget with respect to whale watching vessels, first-order Markov chain analyses were used to build transition matrices and run Monte Carlo simulations in situations in which whales were in the presence of vessels and in the absence of vessels (presence vs. absence). A first-order Markov chain was deemed appropriate for accounting for temporal autocorrelation while quantifying the dependence of a succeeding behavioral state (Lusseau, 2003). Based on the resulting contingency tables, presence and absence transition probability matrices were calculated (for details, see Di Clemente et al. 2018).

Monte Carlo simulations were also used to estimate the activity budgets of whales during vessel presence and absence situations (for details, see Christiansen et al., 2013b and Di Clemente et al., 2018). For presence and absence situations, simulations were repeated 1000 times, each representing a 7.5-h long time series either in the presence or the absence of whale-watching vessels. The resulting distribution was plotted using the relative proportion of each behavioral state in each situation. Initial model runs indicated that RES could not be included in Monte Carlo simulations due to its infrequent occurrence that resulted in a 100% transition probability. RES was therefore not included in the simulations.

3. Results

Data were collected on 147 days (111 days from Point Lena and 36 days from Point Retreat) from June through October 2016 and May through September 2017, totaling 843 h of effort (621 h from Point Lena, 223 h from Point Retreat) (Table 1.3). Only sightings consisting of ≥ 10 min of observed behaviors were included to ensure adequate IBI sample size. Tracks composed of ≥ 4 fixes were included to ensure at least two data points were included for deviation analysis. With these considerations, 201 humpback whale sightings and 178 whale tracks were included for analysis. This amounted to a total of 162 h of behavioral observations (Table 1.3). The mean duration of a sighting was 49 ± 47.7 SD min (range = 12 - 447 min). The mean number of fixes in a track was 18 ± 24.3 (range = 4 - 213).

3.1 Presence and number of vessels (Obj. 1)

Summary statistics for deviation, speed, and IBI were calculated in the presence and absence of vessels (Table 1.4). The mean number of vessels observed for each fix was 0.8 ± 1.41 (range = 0 - 8). The estimated whale deviation from their straight-line course was 38.9% higher in the presence of vessels than in the absence of vessels based on the AICc-best model (p <0.001, Table 1.5). Using the number of vessels instead of vessel presence in the same model resulted in an estimated increase in deviation by 6.2% per additional vessel (p = 0.022, Appendix 1-A), but the model had less support (ΔAICc = 14.77). Whale swimming speed was 5.4% faster in the presence vs. absence of vessels (p = 0.047, Table 1.6). However, the number of vessels did not have a significant effect on speed. While IBI was 6.7% shorter in the presence vs. absence of vessels (p = 0.025, Appendix 1-A), AICc model comparisons indicated that a linear effect of the number of vessels on IBI resulted in a better model (ΔAICc = 5.78), suggesting a 3.4% decrease in IBI for each additional vessel (p = 0.001, Table 1.7). For neither deviation, speed nor IBI did the categorical model for number of vessels indicate an obvious threshold effect.

3.2 Percent time spent with vessels (Obj. 2)

The mean percent time humpback whales were observed in the presence of vessels was 33% (39.2% SD, range = 1-100%) during tracks and 29% (36.7% SD, range = 1-100%) during sightings. During 40% of tracks and 44% of sightings, no vessels were present. During 16% of tracks and 11% of sightings, vessels were present for the entire time. Humpback whale directionality averaged 0.72 (0.308 SD, range = 0.01-1.00, n = 177) and RESP averaged 0.55 breaths/min (0.256 SD, range = 0.16-1.52, n = 201). Percent time spent in the presence of vessels did not significantly affect directionality. However, the best fit model for RESP included percent time spent with boats, behavioral state, date, and location, and indicated that the more time a whale spent in the presence of vessels during a track, the higher the RESP ($p = 0.011$).

3.3 Behavioral state transitions (Obj. 3)

A total of 5,489 behavioral events were recorded during 201 sightings (presence: 40.3%, n = 2213; absence: 59.7%, n = 3,276; Table 1.8). In the presence and absence of vessels, the predominant behavioral state observed was TRA (presence: 66.6%, absence: 76.1%), followed by FED (presence: 31.7%, absence: 21.5%), RES (presence: 1.4%, absence: 1.6%), and SAB (presence: 0.3%, absence: 0.8%). Markov chain analysis including TRA, FED, and SAB indicated that the transition probability between behavioral states differed by vessel presence (goodness-of-fit test, $\chi^2 = 33.4$; df = 4; $p < 0.001$). In the presence and absence of vessels, whales were likely to continue engaging in FED and TRA (FED → FED, presence = 96.7%, absence = 95.7%; TRA → TRA, presence = 98.2%, absence = 98.5%). In the presence of vessels, SAB more frequently transitioned to FED (SAB → FED, presence = 42.9%, absence = 3.7%) or TRA (SAB → TRA, presence = 14.3%, absence = 7.4%), while in the absence of vessels, whales were more likely to continue SAB (SAB → SAB, absence = 88.9%, presence = 42.9%).

Monte Carlo simulations indicated that in the presence of vessels, the activity budgets of whales included less TRA and SAB (Figure 1.2). In the presence of whale watching vessels, TRA composed

71.1% of the activity budget, compared to 80.7% in the absence of vessels, and SAB was 0.2% in the presence of vessels, compared to 0.9% in the absence of vessels. FED was also a large proportion of the activity budgets of whales, consisting of 28.6% in the presence of vessels and 18.4% in the absence (Table 1.9).

4. Discussion

The results of this study reveal differences in humpback whale movement and behavior according to the presence of vessels, number of vessels, and time spent with vessels. Overall, in the presence of vessels, humpback whales demonstrated a larger deviation from their straight-line path, higher swimming speeds, and shorter IBIs. Higher deviation and shorter IBIs were also associated with the number of vessels, deviation significantly increasing and IBI significantly decreasing with each additional vessel present. A higher percentage of time spent with vessels was also correlated with higher RESP. Humpback whales that were feeding or traveling were likely to continue in those behavioral states whether in the presence or absence of vessels, but individuals were more likely to cease surface activity in the presence of vessels.

4.1 Whale watching vessels (Obj. 1)

Horizontal movement metrics, such as changes in direction and increased swimming speed, are often used to identify vessel avoidance strategies by whales (Baker and Herman, 1989; Schaffar et al., 2013; Christiansen et al., 2014). The present study detected both a 38.5% higher deviation and 5% higher speed in the presence of vessels. Humpback whales have previously demonstrated increased path sinuosity (Schaffar et al., 2009; Stamation et al., 2010) and avoidance orientation in relation to vessels (Baker and Herman, 1989). Increased speeds in the presence of vessels has also been detected on humpback whale breeding grounds in the South Pacific (Schaffar et al., 2013) and South Atlantic (Morete et al., 2007). Direction changes and increased speeds are an energetically efficient strategy for humpback whales to avoid a perceived threat (Ford and Reeves, 2008; Senigaglia et al., 2016). While this ‘flight’ response may require less energy than a 'fight' response (i.e., surface-active behaviors) (Pitman et al., 2017), increased energetic expenditure spent avoiding vessels in highly trafficked areas, like Juneau, could be cumulative and decrease physical fitness over time.

Indicators of disturbance include changes in dive patterns and surfacing intervals (Bejder and Samuels, 2003). In the present study, shorter IBI in the presence of vessels indicates an increase in blow frequency. Furthermore, as the number of vessels increased, humpback whales exhibited significantly shorter IBI. These results support a meta-analysis by Senigaglia et al. (2016), which determined that mysticetes (i.e., baleen whales) tended to decrease IBI when whale watching vessels were present. Previous studies in Juneau have also associated the presence of vessels with changes in breathing intervals (Baker et al., 1986) and increased variability in time spent at the surface (Peterson, 2001). Similarly, fin whales (*Balaenoptera physalus*) off the coast of Maine exhibited higher respiration rates and reduced dive durations, surface durations, and number of blows per surfacing sequence when whale watching vessels were nearby (Stone et al., 1992). A decrease in IBI during interactions with whale watching vessels can be of particular concern when it indicates a relative decrease in foraging efficiency, as seen in minke (*B. acutorostrata*) and fin whales (Christiansen et al., 2013a; Lesage et al., 2017). Furthermore, shorter IBI in the presence of vessels can reflect increased energetic expenditure and result in higher levels of oxygen consumption needed to recover (e.g., from increased speed to avoid vessels) (Christiansen et al., 2014).

4.2 Time spent with vessels (Obj. 2)

As the percent time spent with vessels increased, the respiration rate increased. Over the course of a track, whales may be disturbed by vessel noise of tracking whale watching vessels (Richardson et al., 1995) due to the strong or rapid changes in engine and propeller speed (Watkins, 1986). Alterations in whale breathing patterns to persistent vessel exposure can indicate vessel avoidance of these sound levels. Multiple vessels simultaneously tracking a whale will accentuate this effect (Holt et al., 2009). While the present study considered vessels present as those tracking whales within 500 m, it is likely that the vessel detection range for whales is > 500 m (Baker and Herman, 1989; Richardson et al., 1995) as cetaceans respond to stimuli as far as tens of kilometers away (Baker and Herman, 1989; Richardson et al., 1995). Therefore, disturbance from vessel noise may be heightened in heavily trafficked areas, like Juneau. While not measured in the current study, information regarding detectable ranges of vessel engine sound in the tour area, and observations of whale movement and behavior with larger vessel distance thresholds, would help to validate this supposition.

4.3 Behavioral state transitions (Obj. 3)

The present study reflects results from data collected in Juneau by Di Clemente et al. (2018), which demonstrated that humpback whale activity budgets in the presence of vessels consisted of less traveling and more feeding than in the absence of vessels. This could also reflect that whale watching tours are more likely to select a feeding whale to watch over a traveling whale. However, humpback whales did not alter their feeding or traveling behaviors based on vessel presence. Previous research in Alaska has indicated that feeding humpback whales are less likely to alter their behavioral state in response to approaching vessels than non-feeding whales (Krieger and Wing, 1984; 1986; Peterson, 2001), suggesting that the need to build energy reserves while on the feeding grounds supersedes abandoning feeding even if disturbed. Responses may also occur beneath the surface, such as decreases in humpback whales feeding efficiency as seen with increased sound levels from vessels (Blair et al., 2016). By contrast, minke whales in Faxaflói Bay, Iceland, decreased feeding behavior as a result of whale watching vessel presence (Christiansen et al., 2013a). Differences in observed responses may vary by prey type, prey densities, and availability of food elsewhere (Krieger and Wing, 1986).

The only significant effect of vessel presence on humpback whale activity budgets was with respect to surface active behavior. Similar to Di Clemente et al. (2018), humpback whales in the absence of vessels were more than twice as likely to continue surface active behaviors, and whales in the presence of vessels were twice as likely to transition from surface active behavior to traveling. In other studies in Alaska, humpback whales increased surface active behaviors in the presence of vessels, potentially representing aggressive (e.g., tail breaching and lob tailing) and negative responses to vessels (Baker and Herman, 1989; Peterson, 2001). Transitions from vocal communication to non-vocal surface-generated communication (i.e., breaching, tail-slapping) by humpback whales have also been detected in noisy environments (i.e., increased background noise, high wind speeds) (Dunlop et al., 2010). However, surface active behavior has also been attributed to communication to distant groups (Kavanagh et al., 2017). This indicates that cessation of surface active behavior could result from acoustic masking due to vessel noise and subsequent inability to communicate (Richardson et al., 1995; Gabriele et al., 2018). However, due to the relatively small proportion of time a whale spends resting and in surface active behaviors, in comparison to feeding and traveling, a larger sample size is needed to support the findings of the present study.

4.4 Potential long-term effects

The present study did not directly address long-term consequences of vessel presence; however, it is possible that the measured short-term effects on whale movement and behavior could have cumulative effects on individuals and local populations in areas of high disturbance. Increased energetic expenditure and potential decreases in feeding efficiency, as evidenced by increased direction changes, higher traveling speeds, and changes in breathing and diving patterns, could have negative long-term effects. Prolonged energetic expenditure due to vessel avoidance behaviors may deplete energy reserves and disrupt homeostasis, ultimately causing physical fitness decline in whales (Beale, 2007). These physiological consequences, if extreme enough, could cause population decline, influencing reproductive success or decreasing chances of survival (Bejder and Samuels, 2003).

Humpback whales exhibit a high degree of feeding site fidelity (Calambokidis et al., 2001; Weinrich and Corbelli, 2009) to both general feeding areas (Baker et al., 1990) and to specific regions within the feeding grounds (Weinrich, 1998; Stevick et al., 2006). This may be an adaptive strategy to maximize prey intake by feeding on “known” prey resources that are predictable in time and space (Stevick et al., 2006). Humpback whales that remain in highly trafficked areas despite high exposure to vessel presence and associated stressors may do so because they rely on the resources from that area or they no longer perceive the presence of vessels as a threat.

Negative effects on whales may be minimized over time by habituation to vessel presence (Watkins, 1986). On the New England feeding grounds, Watkins (1986) determined that since whale watching began in 1976, humpback whales in the presence of vessels are more likely to continue their previous activity or respond by approaching vessels. Furthermore, despite high vessel pressure in the Juneau tour area, several individual humpback whales continue to return in subsequent years, often being observed multiple times a season (Teerlink, 2017). In a study by Teerlink et al. (2018), humpback whales in the Juneau area at the end of a whale watching season (September) did not exhibit higher levels of the stress hormone, cortisol, compared to more remote regions. The lack of physiological stress responses detected in humpback whales in Juneau could indicate that repeated short-term disturbances may not be causing chronic stress. However, it is also possible that whales more sensitive to the presence of vessels had already left the tour area to avoid vessels, and the samples of whales in Juneau were biased towards whales more tolerant of vessels (Bejder et al., 2006a).

The expansion and persistence of vessel presence could result in alteration of humpback whale ranging patterns or habitat utilization. Changes in humpback whale distribution in an effort to avoid vessels could be detrimental not only to the whales, but to the profitability of the Juneau tour industry. In nearby Glacier Bay, habitat abandonment by humpback whales in response to vessel exposure has already been documented (Dean et al., 1985). Similarly, individual humpback whale singers in Brazil have responded to high vessel traffic by either moving out of recording range or discontinuing songs (Sousa-Lima and Clark, 2008). Bottlenose dolphins in Milford Sound, New Zealand have also adjusted their seasonal residency patterns in response to heavy vessel traffic (Lusseau, 2005).

4.5 Management recommendations

Regulations were established in Alaska to prevent “take”, defined under the MMPA as an action to “harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal". The present study revealed that there are significant differences in short-term whale movement and behavioral patterns in the presence of vessels. This indicates that the current regulations, including to "not disrupt the normal behavior or prior activity of a whale" (Table 1.1), may not be adequate to reduce takes of humpback whales. Therefore, revisiting the humpback whale approach regulation and expanding the existing vessel approach limit to create a larger buffer around the whales should be considered by management to help reduce vessel impacts on humpback whales. The present study also determined that changes in deviation and IBI occurred in response to the number of vessels. Restrictions on the maximum number of vessels around whales or limits to the number of vessels in the industry does not currently exist. Managing the number of vessels watching whales would minimize vessel effects on whale movements and behavior.

The management approach in Alaska should continue to be supplemented with education programs encouraging operator participation in voluntary best practices. Whale SENSE was introduced in Alaska in 2015 (NOAA Fisheries and Whale and Dolphin Conservation, 2018). In 2018, 44% of the companies that offered dedicated whale watching tours in Juneau participated in the program, consisting of approximately 67% vessels in the industry (Schuler, unpublished data). This program aims to minimize harassment of whales through the education of naturalists, captains, and passengers and promotion of responsible whale watching practices. Programs such as Whale SENSE can help to manage viewing expectations and encourage operator compliance (Filby et al., 2015). By combining evidenced-based regulations with effective educational programs, a sustainable whale watching industry can be maintained.

5. Conclusion

The whale watching industry in Juneau, Alaska, has grown alongside increasing humpback whale populations and rising tourist demand over the past 20 years. The present study revealed significant short-term differences in humpback whale movement and behavior in the presence of vessels that could negatively impacting the health and predictability of the resource on which the industry relies. To determine if the short-term behavioral effects observed in this study manifest into long-term fitness consequences, the population should continue to be monitored. In the meantime, it is recommended that management bodies revisit the current regulations and guidelines, incorporating recent scientific research findings, to ensure the sustainability of the industry. The precautionary principle, which should provide a buffer for scientific uncertainty (Reynolds III et al., 2009), and proactive approaches should be implemented in order to ensure the viability of the whale watching industry and the species upon which it depends.

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Figures

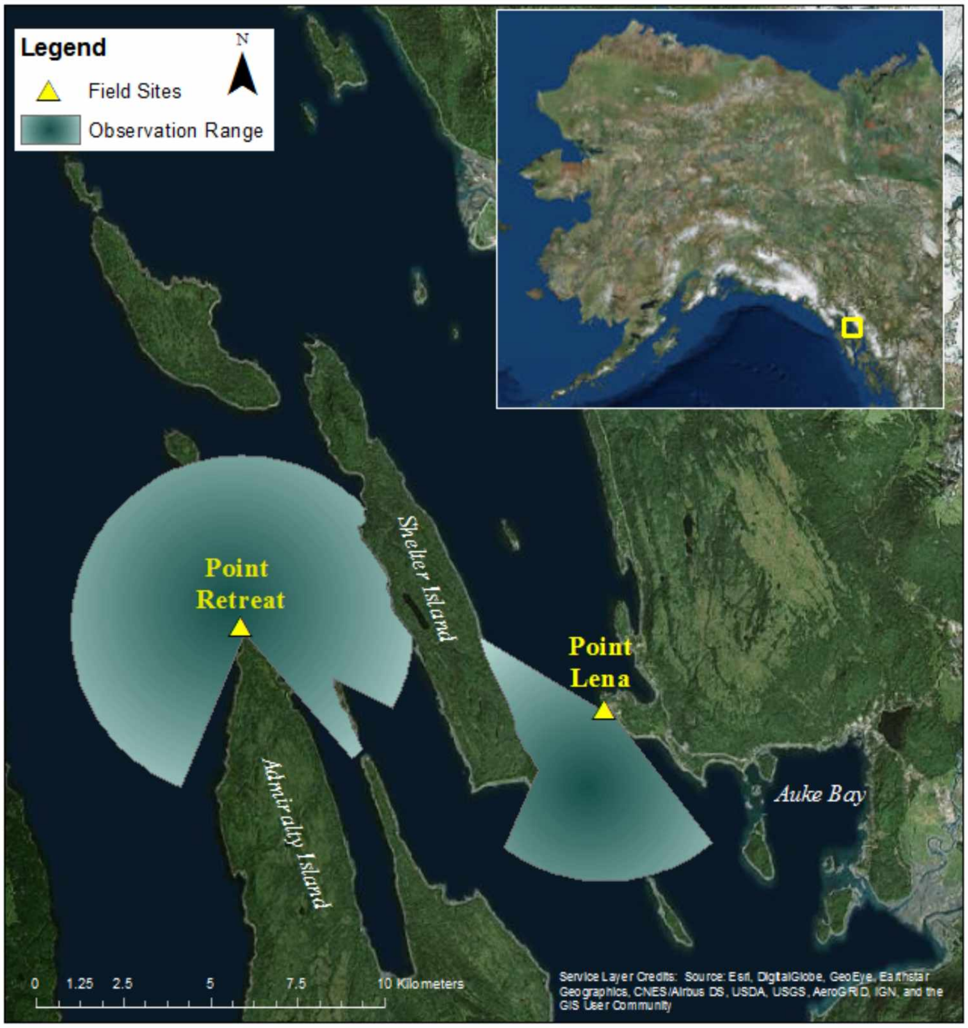

Figure 1.1. Map of Juneau whale watch tour area with field sites and corresponding observation ranges up to 5 km. Field sites were located at Point Lena (58.39140 N, 134.77495 W), at the NOAA Ted Steven's Marine Research Institute, and Point Retreat (58.41308 N, 134.95644 W), at the lighthouse on the northern point of Admiralty Island. Most whale watching vessels depart from Auke Bay, with both sites located within the typical tour area. Each site was positioned at a high vantage point necessary for observing and tracking whales using a theodolite accurately up to 5 km (station height of 37.2 m, and 21.9 m, respectively).

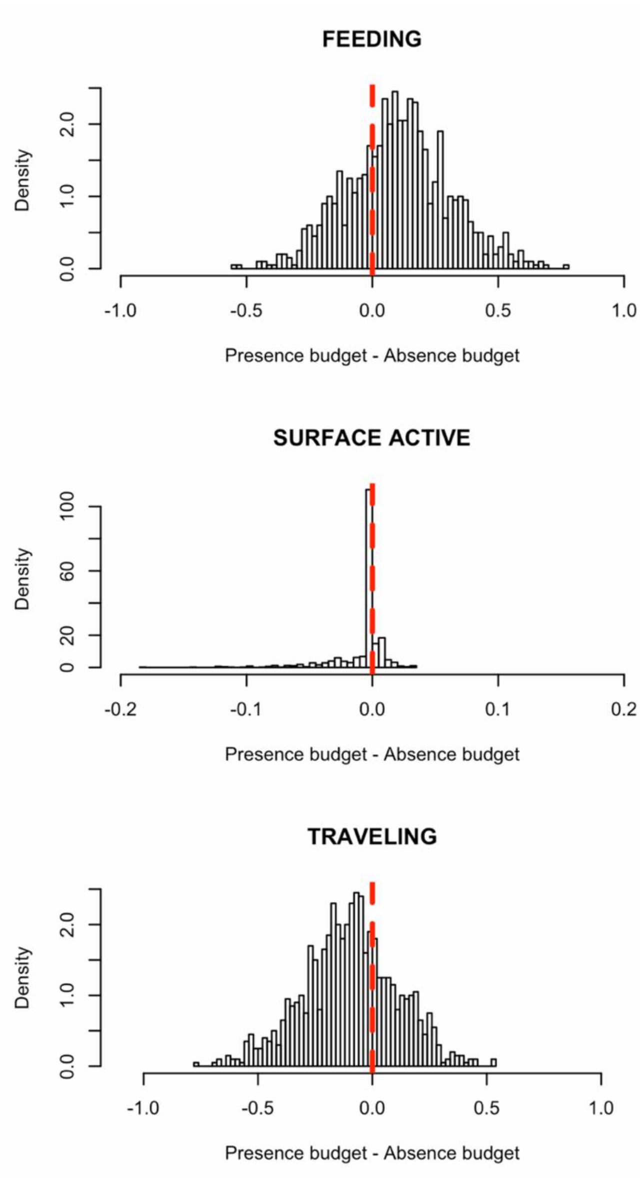

Figure 1.2. Difference in activity budgets (proportion of time spent in behavioral states) between vessel presence and vessel absence situations. The density distributions derive from 1000 Monte Carlo simulated sightings, each representing a 7.5-h long time series either in the presence or the absence of whale-watching vessels. An increase in each state in the presence of vessels is indicated by a positive difference, whereas decrease in each state in the presence of vessels is shown as a negative difference. No difference is represented by red dashed lines.

Tables

Table 1.1. Federal regulations and guidelines for viewing humpback whales and marine mammals in Alaska (NOAA, 2016)

Regulations and Guidelines in Alaska	
NOAA Humpback Whale Approach Regulations require that you:	1) Not approach within 100 yards of a humpback whale
	2) Not place your vessel in the path of oncoming humpback whales causing them to surface within 100 yards of your vessel
	3) Not disrupt the normal behavior or prior activity of a whale
	4) Operate at a slow, safe speed when near humpback whales
General Marine Mammal Viewing Code of Conduct recommendations:	1) Remain at least 100 yards from marine mammals
	2) Time observing individual(s) should be limited to 30 minutes
	3) Whales should not be encircled or trapped between boats, or boats and shore
	4) If approached by a whale, put the engine in neutral and allow the whale to pass

Table 1.2. Behavioral ethogram for observations of humpback whales in Juneau. Any recorded event not identified was marked as 'Unidentified'. Modified from Whale and Dolphin Conservation (2015) and Di Clemente et al. (2018).

BEHAVIORAL STATE	BEHAVIORAL EVENT	DESCRIPTION
Feeding (*frequent changes in directional movement or observed surface feeding*)	*lunge feeding*	Rapid surfacing with pleats extended. At the surface, the mouth is closed as prey items are filtered from the water. Surfacing may be either lateral or vertical
	open mouth feeding	Slow surfacing with an open mouth, baleen visible, and pleats extended
Resting *(slow, directionless movement with slow activity level)*	*logging*	Stationary horizontal position at the surface lasting > 30 seconds
Surface Active *(aerial activity that breaks the surface of the water)*	*chin slapping*	Propelling the body out of the water vertically, without spinning. The ventral side makes contact with the water surface
	flipper slapping	The whale slaps its pectoral flippers on the water's surface
	full breach	Propelling more than half of the body out of the water, spinning either clockwise or counter clockwise
	half breach	Breaching with half or less of the body out of the water
	lob tailing	Stationary horizontal position in the water, repeated slapping of the fluke onto the water's surface, with dorsal side visible
	rolling	When horizontal in the water, a partial or complete body rotation at the surface
	spy hopping	Surfacing head-first either at an angle or vertically, rostrum visible, mouth closed
	tail breaching	Surfacing the tail-first and forcefully throwing the peduncle laterally out of the water
Travelling *(steady, directional movement)*	*fluke low dive*	Raising the fluke above the surface. The dorsal side of the fluke is visible, little to no view of the ventral pigmentation pattern of the fluke
	fluke up dive	Raising the fluke above the surface. Ventral fluke pigmentation pattern visible

Table 1.3. Summary of research effort for single adult whales at Point Lena and Point Retreat for 2016 and 2017 field seasons.

Month	Location	Data collection days		Survey Hours		Number of follows		Focal follow hours		Number of fixes	
		2016	*2017*	*2016*	*2017*	*2016*	*2017*	*2016*	*2017*	*2016*	*2017*
May	*Point Lena*	0	4	0	22	0	12	0	8	0	193
	Point Retreat	0	0	0	0	0	0	0	0	0	0
June	*Point Lena*	13	19	94	105	15	41	8	34	138	896
	Point Retreat	0	5	0	40	0	20	0	22	0	599
July	*Point Lena*	19	13	115	81	19	16	12	8	163	165
	Point Retreat	5	12	36	69	3	20	2	15	30	157
August	*Point Lena*	13	12	70	64	5	9	4	6	56	73
	Point Retreat	7	4	41	26	12	12	14	19	267	425
September	*Point Lena*	11	6	45	23	10	4	7	2	94	27
	Point Retreat	0	3	0	11	0	2	0.0	4	0	42
October	*Point Lena*	1	0	4	0	1	0	1	0.0	5	0
	Point Retreat	0	0	0	0	0	0	0.0	0.0	0	0
Total		69	78	405	441	65	136	48	118	753	2577

Table 1.4. Summary statistics for movement and behavioral metrics, deviation, speed, and inter-breath interval (IBI).

		Mean ± SD	*Min*	*Max*	*n*
Deviation (deg)	Absence	41 ± 44.1	0.02	180.00	1271
	Presence	55 ± 49.3	0.02	179.99	1679
Speed (kph)	Absence	5 ± 3.0	0.01	22.18	1886
	Presence	5 ± 3.3	0.04	22.58	1250
IBI (sec)	Absence	117 ± 180.5	4	1193	2035
	Presence	83 ± 133.8	4	1202	3361

Table 1.5. Estimated coefficients and standard errors from the AICc-best linear mixed effects model of the effects of vessel presence on log (Deviation) (n=2950 fixes) while controlling for behavioral state, location, Julian date, Beaufort sea state, distance from site, and time between fixes. The intercept is the estimated mean log(Deviation) at the reference group (Ref), while other coefficients are differences from the Ref.

	Value	Std.Error	p-value
(Intercept)	2.806	0.323	*<0.001*
Vessel Absence	Ref	Ref	Ref
Vessel Presence	**0.329**	**0.077**	***<0.001***
Behavioral State: Travelling	Ref	Ref	Ref
Behavioral State: Feeding	0.602	0.090	*<0.001*
Behavioral State: Resting	-0.860	0.364	*0.018*
Behavioral State: Surface active	0.489	0.453	0.281
Location: Point Lena	Ref	Ref	Ref
Location: Point Retreat	0.563	0.098	*<0.001*
Julian Date	-0.006	0.002	*<0.001*
Distance from site	0.000	0.000	*<0.001*
Time between fixes	0.059	0.007	*<0.001*

Significant p-values are in Italic type

Ref = reference group in the analysis

Table 1.6. Estimated coefficients and standard errors from the AICc-best linear mixed effects model of the effect of vessel presence on sqrt (Speed) (n=3,136 fixes) while controlling for behavioral state, year, location, and distance from site. The intercept is the estimated mean sqrt (Speed) at the reference group (Ref), while other coefficients are differences from the Ref.

	Value	Std.Error	p-value
(Intercept)	2.265	0.053	*<0.001*
Vessel Absence	Ref	Ref	Ref
Vessel Presence	**0.060**	**0.030**	***0.048***
Behavioral State: Travelling	Ref	Ref	Ref
Behavioral State: Feeding	-0.036	0.036	0.310
Behavioral State: Resting	-0.528	0.146	*<0.001*
Behavioral State: Surface active	-0.285	0.179	0.110
Point Lena	Ref	Ref	Ref
Point Retreat	-0.100	0.051	0.051
Year: 2016	Ref	Ref	Ref
Year: 2017	-0.068	0.041	0.099
Distance from Site	0.000	0.000	*0.001*
Significant p-values are in Italic type			
Ref = reference group in the analysis			

Table 1.7. Estimated coefficients and standard errors from the AICc-best linear mixed effects model of the simple linear effect of number of vessels on log Inter-Breath Interval (IBI) (n = 5,396 observations), while controlling for behavioral state, location, time, Julian date, year, and dive type. The intercept is the estimated mean log(IBI) in the absence of vessels and at the reference group (Ref), while other coefficients are differences from the Ref.

	Value	Std.Error	p-value
(Intercept)	5.352	0.285	*<0.001*
Number of Vessels	**-0.035**	**0.011**	***<0.001***
Behavioral State: Travelling	Ref	Ref	Ref
Behavioral State: Feeding	-0.010	0.039	0.808
Behavioral State: Resting	0.448	0.167	*0.008*
Behavioral State: Surface active	-0.345	0.174	*0.048*
Time	0.460	0.150	*0.002*
Julian Date	0.005	0.001	*<0.001*
Year: 2016	Ref	Ref	Ref
Year: 2017	-0.212	0.100	*0.035*
Location: Point Lena	Ref	Ref	Ref
Location: Point Retreat	-0.421	0.068	*<0.001*
Dive Type: Fluke Up	Ref	Ref	Ref
Dive Type: No fluke	-2.375	0.036	*<0.001*

Significant p-values are in Italic type

Ref = reference group in the analysis

Table 1.8. Number of observations of whales in Juneau waters according to behavior states for presence (with whale watching vessels) and absence (without whale watching vessels) situations.

Behavior State	Presence		Absence	
Feeding (FED)	701	(31.68%)	704	(21.49%)
Resting (RES)	31	(1.40%)	52	(1.59%)
Surface Active (SAB)	7	(0.32%)	27	(0.82%)
Traveling (TRA)	1474	(66.61%)	2493	(76.10%)

Table 1.9. Activity budgets of whales during vessel presence and vessel absence situations, estimated by Monte Carlo simulations.

BEHAVIOR STATE	*ACTIVITY BUDGET*	*MEAN ± SD*	*HPD*
Feeding (FED)	Absence	0.1839 ± 0.133	0 - 0.442
	Presence	0.2863 ± 0.160	0 - 0.585
Surface active (SAB)	Absence	0.0088 ± 0.021	0 - 0.049
	Presence	0.0023 ± 0.005	0 - 0.014
Traveling (TRA)	Absence	0.8073 ± 0.133	0.545 - 1.000
	Presence	0.7114 ± 0.160	0.411 – 1.000

HPD = 95% highest posterior density interval; SD = standard deviation.

Chapter 2: Conservation benefits of whale watching in Juneau, Alaska[4]

Abstract

The present study investigated whale-watching tours in Juneau, Alaska, and their role as a conduit for conservation of whales and the environment. Passenger knowledge, intentions, behaviors, and attitudes were obtained from 2331 surveys before, immediately after, and 6 months after a whale-watching tour. Compared to before a whale-watching tour, whale watching as source of participant knowledge increased, awareness of whale watching guidelines/regulations doubled, and strong support for guidelines/regulations increased immediately following a whale-watching tour and six months after (all $p < 0.010$). Strong support of guidelines/regulations was more likely if participants were aware of guidelines/regulations ($p < 0.001$) and less likely if participants disagreed (vs. agreed) that boats have a negative impact on whales ($p = 0.027$). Participants that acknowledged human impacts on whales and their habitat had stronger pro-environmental attitudes. This study indicates that awareness of guidelines/regulations can support conservation of whales through managing expectations and ultimately encouraging operator compliance.

1. Introduction

Over the last century, the way that people value and interact with whales and dolphins has fundamentally changed. Once extracted and used as an economic commodity, the global moratorium on whaling by the International Whaling Commission in 1986 sought to save the great whales from extinction (International Whaling Commission, 2018). Concomitantly, the demand for seeing whales in the wild has expanded globally since the inception of whale watching in the 1950s (O'Connor, Campbell, Cortez, & Knowles, 2009). The global annual economic value for whale watching in 2008 was estimated to be $2.1 billion dollars, with over 13 million whale watchers in 119 countries (O'Connor, et al., 2009).

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[4] Schuler, A.R., Pearson, H.C. Conservation benefits of whale watching in Juneau, Alaska. Manuscript in preparation for *Tourism Management*.

In the United States alone, revenue was estimated to be $1 billion, consisting of 5 million whale watchers (O'Connor, et al., 2009). Often regarded as a form of ecotourism, a whale-watching industry can benefit the communities where it takes place, including stimulating the local economy, providing employment opportunities, and supporting the protection of natural areas and wildlife (Higginbottom, Northrope, & Green, 2001).

Whale watching can support the protection of whales by providing opportunities for tourists to learn about whales and their environment while experiencing natural areas. Participants often expect to be educated on whale watching tours, and enjoy learning about whales and the marine environment (Filby, Stockin, & Scarpaci, 2015; Lück, 2003; Russell & Hodson, 2002). Following a whale-watching tour, participants have demonstrated greater knowledge about cetaceans (Filby, et al., 2015; Mayes & Richins, 2009), awareness of threats to cetaceans (Filby, et al., 2015; Finkler & Higham, 2004), greater pro-environmental attitudes (Christensen, Rowe, & Needham, 2007), and increased support for conservation of whales and marine environments (Christensen, Needham, & Rowe, 2009). In the long-term, previous studies have indicated that the experience and knowledge obtained from the whale-watching tour can contribute towards lasting pro-environmental attitudes and behaviors (Orams, 1997; Zeppel & Muloin, 2009).

By contrast, others argue that ecotourism can lack conservation gain and harm the natural resources upon which the industry depends (Steele, 1993). Education programs can be ineffective because environmental knowledge alone is not enough to influence environmental attitudes and behaviors (Beaumont, 2001; Gralton, Sinclair, & Purnell, 2004). Also, Stamation, Croft, Shaughnessy, Waples, and Briggs (2007) determined that while participants have indicated knowledge and pro-environmental intentions following their whale watching tour, they were unlikely to remember what they learned during their whale watch experience and did not change the rate at which they carried out pro-environmental behaviors 6-8 months later. The presence of the whale watching vessels themselves may also negatively impact the whales (Parsons, 2012). Whales have demonstrated changes in direction, higher speeds, and higher breath rates in the presence of whale watching vessels (Chapter 1). These short-term changes can accumulate to long-term fitness consequences for whales if more time and energy is spent avoiding vessels than performing behaviors such as foraging and resting that are essential for body maintenance (Lusseau & Bejder, 2007; Parsons, 2012). Disturbances from vessel presence may also result in whales altering their distribution and habitat use (Bejder, et al., 2006; Cartwright, et al., 2012).

Many regions have created guidelines and regulations to mitigate any potential disturbance on whales by whale watching vessels (Carlson, 2010). In the United States, each National Oceanic and Atmosphere Administration (NOAA) Fisheries Regional Office develops whale watching guidelines and regulations to support protections afforded by the Marine Mammal Protection Act (MMPA). Further efforts to manage local industries include voluntary programs, like Whale SENSE (NOAA Fisheries & Whale and Dolphin Conservation, 2018), that exist in the Atlantic and Alaska regions. This voluntary program encourages operators to follow additional viewing guidelines and complete annual trainings, and recognizes participants on their website (www.whalesense.org). Incorporating effective interpretation of guidelines and regulations has the potential to be a proactive management strategy to avoid negatively affecting whale populations where whale watching industries exist (Andersen & Miller, 2006). Further, increasing whale watch participant knowledge and awareness has been found to encourage operator compliance to regulations (Filby, et al., 2015).

The whale watching industry in Juneau, Alaska has become increasingly lucrative alongside a growing number of cruise ship passengers that visit each summer. As a city only accessible by boat or by plane, cruise ships contribute 93% of all visitors to Juneau, totaling over one million people each year (Di Clemente, et al., 2018; McDowell Group, 2017). Approximately one third of visitors participated in whale watching and other day cruises in 2016 (McDowell Group, 2017). The annual revenue of the whale watching industry was estimated to be $32 million in 2006 (Dugan, Fay, Griego, & Colt, 2009); however, the industry has likely increased in value since then. In 2018, the number of visitors in Juneau has grown 23% since 2006, and projected to be 48% higher in 2019 vs. 2018 (Rain Coast Data, 2018). A reliable presence of humpback whales (*Megaptera novaeangliae*) and opportunistic sightings of killer whales (*Orcinus orca*) has resulted in all dedicated whale watching operations offering a whale sighting money back guarantee (S. Teerlink, Alaska Regional Office, NMFS, pers. comm., 18 February 2019). The Juneau whale-watching industry consists of approximately 65 dedicated whale watching vessels, in addition to opportunistic whale watching that occurs with fishing charter vessels (Di Clemente, et al., 2018). Of the vessels that offered dedicated whale watching tours in Juneau in 2018, approximately 67% participated in the Whale SENSE program (Schuler, unpublished data).

As more people participate in whale watching tours and whale watching vessel presence increases, maintaining a sustainable industry that supports conservation and protection of local whale populations will be essential. The overall goal of this study was to determine whether whale watching tours in Juneau, Alaska, can be a conduit for conservation of whales and the environment. The first objective of this study identified differences in whale watch participants' knowledge, intentions, behaviors, and attitudes before, after, and 6 months after a whale watching tour. Secondly, this study determined how awareness of whale watching guidelines and regulations, behaviors, attitudes, and demographics influenced whale-watching participants' support of guidelines and regulations. Finally, this study evaluated whether whale-watching participants' behaviors, attitudes towards whale watching, and survey group relate to pro-environmental attitudes.

2. Methods

Paper-and-pencil multiple answer choice surveys were administered by a researcher (A.S.) to participants before (PRE) or after (POST) a whale watching tour to measure knowledge, intentions, behaviors, and attitudes in addition to basic demographic information (Appendix 2-A, Appendix 2-B,). Six months later (POST6M), participants who provided their email address received a survey on the Survey Monkey website (Appendix 2-C).The majority of whale watching tours depart from Auke Bay, approximately 12 miles from downtown Juneau. Since most tourists to Juneau arrive by cruise ship, companies arrange for shuttle buses to pick up and drop off participants at the cruise ship terminal. Participants in this study completed the 5-minute survey on the shuttle bus to or from the whale watching tour. Participants were informed about the goals of the project and notified of the requirements for participating. Survey participation was voluntary, and all survey participants met inclusion criteria of being 18 years or older and able to read and understand spoken and written English. Inclusion criteria was verified by questioning each person individually. Upon completion of the survey, participants were encouraged to include their email address to be entered to win a $50 Amazon gift card. Of the approximately 16 whale watching companies in Juneau, three whale watching companies participated in implementing the surveys. Two companies were selected opportunistically and one was a participant in previous research (Lopez & Pearson, 2017). To be included in the study, a 75% completion rate was required for each survey. All research was carried out under approval of the University of Alaska Southeast Institutional Review Board (#16-13).

2.1 Participants

Survey group was defined by the period of time in which participants completed the survey (PRE, POST, POST6M). Demographic information was included as a series of open-response questions for nationality and sex. Pre-selected options were presented for age (18-24, 25-40, 41-60, 60+). For regression analysis, nationality was recoded to "USA" vs. "Other". Experience was determined by the total number of whale watching tours the participant had partaken in prior to Juneau. For comparisons between survey groups, experience was further divided into "First time" whale watchers and "Experienced" (0 and $\geq$ 1, respectively).

2.2 Knowledge

Participants were asked to choose a single response to "How have you gained most of your knowledge about whales?" from pre-selected options (e.g., TV/movies, internet, whale watch) (Appendix 2A). Participants also responded to "Are you aware of any whale watch guidelines/regulations?" by selecting "Yes" or "No" to determine perceived awareness of NOAA humpback whale approach guidelines and regulations. For those who selected "Yes", knowledge of guidelines and regulations was indicated if they correctly selected all listed guidelines and regulations. In 2016, the Alaska Humpback

Whale Approach Regulations required that operators: 1) not approach within 100 yards of a humpback whale, 2) not place the vessel in the path of oncoming humpback whales causing them to surface within 100 yards of the vessel, and 3) operate at a slow, safe speed when near humpback whales (National Oceanic and Atmospheric Administration, 2016). In 2017, the regulation "Not disrupt the normal behavior or prior activity of a whale" was added by NOAA. General marine mammal viewing code of conduct and Whale SENSE guidelines also suggest limiting time observing individual(s) to 30 minutes.

2.3 Behaviors and Intentions

Pre-selected options for environmental behaviors (e.g., recycling, composting, and energy usage) were listed for participants to "Check all that apply" to "Which of the following environmental activities do you do?" (Appendix 2A). Selected behaviors were recoded as a "Yes" response, while unselected behaviors were recoded as "No". Intention after their whale watch in Juneau was determined by the likelihood of participants to engage in conservation behaviors (i.e. "Go on another whale watch or marine ecotourism trip", "Join or donate to an environmental or conservation organization", and "Tell your friends and family about what you learned"). Responses were on a 3-point Likert-type scale including "Not likely", "Somewhat likely", and "Very likely". Six-months later, participants were asked if they had fulfilled those intentions since their whale watch in Juneau by selecting "Yes" or "No".

2.4 Attitudes

Participant attitudes towards whale watching were evaluated by importance factors and responses regarding the effects of viewing whales from boats. In response to "Which of the following is/was the *single most important* factor in determining the quality of your whale watch experience" participants selected one of pre-selected options (i.e., "getting close to whales", "boat size and number of passengers on board", "seeing the whales do interesting behaviors like feed or leap", "being with the whales for a long time", "being the only boat with the whales", "being respectful to the whales"). In response to "How important is it *to you personally* to be able to see humpback whales in the wild?", a 3-point Likert-type scale included “Not important”, “Somewhat important”, and “Very important”. Participants indicated their agreement or disagreement towards effects of whale watching (i.e., “Observing whales from boats can have negative impacts on whales”; “Observing whales from boats can have positive impacts on people”; “Following whale watch guidelines and regulations is important for the protection of whales”) on a 5-point Likert-type scale including “Strongly disagree”, “Disagree”, “Neither agree nor disagree”, “Agree”, and “Strongly agree”. In regression analyses, when used as independent variables, statements regarding the effects of whale watching were recoded to a 3-point Likert-type scale (disagree, neutral, agree).

Environmental attitudes were assessed using the modified New Environmental Paradigm (NEP) by Luzar, Diagne, Gan, and Henning (1995). The NEP uses six 5-item Likert-type scale statements regarding human conflicts with nature, limits to growth, and the role of humans in nature to measure overall participant pro-environmental attitudes. NEP responses have a value from 1 to 5, with responses reflecting positive environmental attitudes ranking higher. The maximum total score for the NEP is 30.

2.5 Social Desirability

The five-item Socially Desirable Response Set (SDRS) was included to control for socially desirable response tendencies (Hays, Hayashi, & Stewart, 1989). Social desirability is an individual’s tendency to portray a positive self-image at the expense of presenting factual information (Hays, et al., 1989). By measuring social desirability, the study controlled for socially desirable responses concerning pro-social behaviors such as environmental and conservation actions (Pearson, Dawson, & Radecki Breitkopf, 2012). SDRS was included as a covariate in all multivariate models.

2.6 Statistical methods

<u>2.6.1 Objective 1: Identify differences in whale watch participants' knowledge, intentions, behaviors, and attitudes before, after, and 6 months after a whale watching tour</u>

All analyses were performed using the free, open-source software R v.3.4.3 (R Core Team, 2018). Participant responses regarding knowledge, intentions, behaviors, and attitudes were compared across all survey groups (PRE, POST, and POST6M) using Pearson chi-square tests. Intentions and previous whale watching experience were also compared within survey groups using Pearson-chi square tests. Likert-type scale questions on attitudes towards whale watching for each survey group were compared using Wilcoxon rank sum tests.

<u>2.6.2 Objective 2: Determine how awareness of whale watching guidelines and regulations, behaviors, attitudes, and demographics influence whale-watching participant support of guidelines and regulations.</u>

Post-hoc analysis indicated that responses to "Following whale watch guidelines and regulations is important for the protection of whales" lacked variability and would have caused analytic problems, with the majority of responses being "agree" (26%) or "strongly agree" (64%). This may be due to the highly socially desirable nature of an agreeable response. Therefore, after Radecki Breitkopf and Pearson (2009), responses to the dependent variable "Following whale watch guidelines and regulations is important for the protection of whales" were recoded as "Strongly agree" vs. "Other" responses (strongly disagree, disagree, neutral, agree).

Pearson chi-square tests were used to determine significant differences in "Strongly agree" vs. "Other" responses to "Following whale watch guidelines and regulations is important for the protection of whales" in relation to each explanatory variable. Explanatory variables included awareness about whale watching guidelines and regulations, behaviors (membership in an environmental or conservation organization), importance factors, attitudes regarding whale watching, NEP, and demographics (nationality, sex, and age). Significant variables at the bivariate level were then entered into a multivariate model. Binomial logistic regression was used to predict the probability of a participant choosing "Strongly agree" vs. "Other" responses, while controlling for SDRS and survey group. A likelihood ratio test was used to determine the best fit model. The probability of choosing "Strongly agree", the odds ratio (probability of choosing "Strongly agree" divided by the probability of choosing "Other") and a 95% confidence interval for the odds ratio were estimated.

<u>2.6.3 Objective 3: Evaluate whether behaviors, attitudes towards whale watching, and survey group relate to pro-environmental attitudes</u>

Analysis of variance (ANOVA) and pairwise t-tests were used to determine which explanatory variables affected NEP. Explanatory variables tested included behaviors (recycling at home, membership to an environmental or conservation organization), importance factors, attitudes regarding whale watching, and survey group. Significant variables were then included in the linear regression model while controlling for SDRS and demographics (nationality, age, and sex).

3. Results

3.1 Participants

Of the 2385 surveys completed, 2% (n=54) were removed due to < 75% completion rate, resulting in a total of 2331 surveys used in analyses (PRE: N=971, POST: N=1167, POST6M: N=193). Of the number of participants invited to take the survey in 2017, the response rate for the PRE and POST was 60% (this information was not collected in 2016). Participants were primarily from the United States (81%), with the rest from other countries ("Other") around the world (17%) (Table 2.1). The majority of participants were female and over the age of 40 (Table 2.1). There were no significant differences in demographic distributions between the PRE, POST, or POST6M survey groups. For the majority of participants, their whale watch in Juneau was their first whale watch (PRE: 54%, POST: 64%, POST6M: 55%).

3.2 Objective 1

3.2.1 Knowledge

PRE participants attained knowledge about whales primarily through TV and movies (Figure 2.1). There was a significant decrease in the proportion of participants that selected TV and movies between the PRE vs. POST ($p = 0.022$) and PRE vs. POST6M ($p < 0.001$). Instead, the majority of the POST and POST6M participants indicated that their whale watch in Juneau was their primary source of whale information.

The percentage of participants who indicated awareness about guidelines and regulations was double in POST compared to PRE ($p < 0.001$, Table 2.2). Of those who indicated that they were aware of NOAA whale watch guidelines, there was an increase in the percentage of participants who knew "Maintaining a distance of at least 100 yards from humpback whales" between PRE vs. POST ($p = 0.003$) and PRE vs. POST6M (POST6M: $p = 0.021$) and the percentage of participants who knew "Staying with humpback whales for a maximum of 30 minutes" between PRE vs. POST ($p = 0.026$) and PRE vs. POST6M (POST6M: $p = 0.002$) (Table 2.2). The percentage of participants that correctly selected all of the guidelines and regulations listed doubled between the PRE vs. POST6M ($p = 0.008$, Table 2.2).

3.2.2 Intentions and Behaviors

The majority of POST participants indicated that after their whale watch in Juneau, they were very likely to "Go on another whale watch or marine ecotourism trip" and "Tell your friends and family about what you learned" (Table 2.3). Meanwhile, nearly a quarter of participants were very likely to "Join or donate to an environmental or conservation organization" (Table 2.3). In comparison to participants that indicated "Very likely" responses in the POST, there were less participants six-months after the whale watch in Juneau (POST6M) that indicated "Yes" to having "Gone on another whale watch or marine ecotourism trip" ($p < 0.001$) and less that indicated "Yes" to "Joined or donated to an environmental or conservation organization" ($p = 0.043$). However, percentage of POST6M participants that told their friends and family about what they learned was higher than those that indicated "Very likely" intentions in the POST ($p = 0.018$).

Previous whale watching experience did not have a significant effect on POST or POST6M participants' intentions to "Join or donate to an environmental or conservation organization" or "Tell friends and family about what you learned". It also did not affect POST participants' likelihood to "Go on another whale watching or ecotourism trip", but POST6M participants with previous whale watching experience prior to Juneau were significantly more likely to have gone on another whale watching or ecotourism trip six months later ($p < 0.001$, Table 2.4).

The mean number of pre-selected environmental behaviors in which participants from each survey group engaged was 3 (PRE: 3 ± 1.5 (N=971 range= 1-8), POST: 3 ± 1.6 (N=1167, range = 1-8, POST6M: 3 ± 1.7, range=1-8). At least 95% of participants in all survey groups selected at least one environmental behavior. While all environmental behaviors increased POST6M compared to PRE and POST, the only significant result was an increase in "Conserve energy at home" from PRE to POST6M ($p < 0.05$, Table 2.5). For all survey groups, the majority of participants selected "Recycle at home" and "Conserve energy at home" as environmental behaviors that they participate in, while the least participated in environmental behaviors were "Vegetarianism" and "Belong to an environmental organization or charity" (Table 2.5).

3.2.3 Attitudes

The majority of participants in all survey groups indicated that it was very important for them to personally see humpback whales in the wild, with no significant difference in responses between survey groups (PRE: 62%, POST: 61%, POST6M: 72%). The top PRE responses to "Which of the following was the *single most important* factor in determining the quality of your whale watch experience in Juneau?"

were "getting close to the whales" and "seeing the whales do interesting behaviors like feed or leap". For both POST and POST6M, these remained as the top importance factors, with no significant difference between survey groups (Figure 2.2). The percentage of participants that indicated awareness of the NOAA regulation "Maintaining a distance of at least 100 yards from humpback whales" did not significantly affect their selection of "getting close to the whales" as the single most important factor (PRE: 22%, POST: 40%, POST6M: 29%).

The majority of participants agreed or strongly agreed that "Following whale watch guidelines and regulations is important for the protection of whales", with the percentage that strongly agreed significantly increasing between PRE vs. POST ($p = 0.016$) and PRE vs. POST6M ($p = 0.008$; Figure 2.3) (PRE: 60%, POST: 66%, POST6M: 73%). Approximately half of participants were neutral on the statement "Observing whales from boats can have negative impacts on whales" (PRE: 51%, POST: 40%, POST6M: 47%), with the percentage of participants who disagreed higher in the POST vs. PRE ($p < 0.001$) and lower in POST6M vs. POST ($p < 0.001$) (PRE: 27%, POST: 35%, POST6M: 28%). The majority of participants agreed or strongly agreed that "Observing whales from boats can have positive impacts on people" (Figure 2.3), with the percentage that strongly agreed higher in POST6M vs. PRE ($p = 0.001$) and POST6M vs. POST ($p = 0.011$) (PRE: 22%, POST: 27%, POST6M: 37%).

NEP values ranged from 6 to 30. Mean NEP was not significantly different between survey groups (PRE: 24 ± 3.8 (N = 971, range = 11- 30), POST: 24 ± 4.1 (N = 1167, range = 6 – 30), POST6M: 24 ± 3.8 (N= 193, range = 10 – 30).

3.3 Objective 2

To determine variation in "Strongly agree" vs. "Other" (strongly disagree, disagree, neutral, agree) in response to "Following whale watch guidelines and regulations is important for the protection of humpback whales", significant explanatory variables for the strongest model using bivariate analyses and likelihood ratio tests included: awareness of guidelines and regulations, attitudes towards importance factors, attitudes towards negative effects of whale watching vessels, NEP, nationality, sex, and age

(Table 2.6). While survey group was significant in bivariate analysis, likelihood ratio tests indicated that it did not contribute to the best model. In response to "Are you aware of any whale watch guidelines/regulations?" participants that selected "Yes" rather than "No", were 46% more likely to choose "Strongly agree" over "Other" responses (odds ratio: 1.460, 95% CI (1.249,1.668)). In response to "Which of the following was the single most important factor in determining the quality of your whale watch experience?" participants that selected "being respectful of the whales" rather than "getting close to the whales", were 44% more likely to choose "Strongly agree" over "Other" responses (odds ratio: 1.442, 95% CI (1.012, 2.053)). In response to "How important is it *to you personally* to be able to see humpback whales in the wild?", participants that selected "Somewhat important" versus "Very important" were 60% as likely to select "Strongly agree" over "Other" responses (odds ratio: 0.596 (95% CI (0.474,0.749)). Compared to participants that agreed to "Observing whales from boats can have negative impacts on whales," those that were neutral were 68% as likely to select "Strongly agree" (odds ratio: 0.684, (95% CI (0.486, 0.967) and those that disagreed were 65% as likely to select "Strongly agree" (odds ratio: 0.649, (95% CI (0.457, 0.922). For each unit increase in participant NEP, the odds of choosing "Strongly agree" over "Other" responses increased by 15% (odds ratio: 1.147, (95% CI (1.114,1.182). Also, males were 77% as likely to select "Strongly agree" as females (odds ratio: 0.769, (95% CI (0.617, 0.959)) and participants of "USA" nationality were 54% more likely to select "Strongly agree" than those from "Other" nationalities (odds ratio: 1.541 (95% CI (1.134, 2.094).

3.4 Objective 3

Bivariate analysis indicated that behaviors ("Recycle at home" and "Belong to an environmental or conservation organization"), importance factors, attitudes towards whale watching, nationality, and sex were all significant explanatory variables in determining variance in NEP values. Participants that recycled at home or were a part of an environmental organization had a significantly higher NEP than those that did not (Table 2.7). In comparison to "getting close to the whales" as the single most important factor, participants that indicated "being respectful to the whales" had a significantly higher NEP (Table

2.7). In response to “Following whale watch guidelines and regulations are important for the protection of whales”, participants that were neutral had a significantly lower NEP than those that agreed (Table 2.7). However, there was no significant difference in NEP in those that disagreed compared to those that agreed. In comparison to participants that agreed in response to “Observing whales from boats can have negative impacts on whales”, participants had a significantly lower NEP if they were neutral or disagreed. Males had a significantly lower NEP than females and participants of "USA” nationality had a significantly lower NEP than “Other” nationality.

4. Discussion

The present study indicated that whale watching in Alaska has the potential to be a conduit for conservation and protection of whales and the environment. The conservation benefits identified in this study include spreading knowledge and awareness about whales, whale watching, and whale watching guidelines and regulations and increasing support of guidelines and regulations for the protection of whales. Meanwhile, getting close to whales and seeing interesting behaviors like feed or leap (e.g., an activity that breaks the surface of the water), remained the most important factors in a participant’s whale watch. With regulations in place prohibiting close encounters with whales, fostering passenger understanding of whales and whale watching will be essential in managing expectations of these importance factors and ultimately developing operator support of responsible whale watching practices. Furthermore, participants had a higher likelihood of strongly supporting guidelines and regulations if they indicated that boats can have a negative impact on whales or were aware of guidelines and regulations. Lastly, participants with higher overall pro-environmental attitudes, indicated by higher NEP scores, were more likely to recognize human impacts on nature. Higher NEP scores were more likely in participants that indicated importance in being respectful to whales and agreed that boats can have a negative impact on whales.

Following the whale watching tour, the majority of participants in the present study indicated their whale watching tour in Juneau as the primary source of knowledge about whales and there was a significant increase in participant awareness of whale watching guidelines and regulations. Other studies of whale watching tourism have indicated that participants want to learn (Filby, et al., 2015; Lück, 2003, 2015; Russell & Hodson, 2002), and are more satisfied with their tour when there is information provided about whales and the marine environment (Andersen & Miller, 2006). Other studies argue that information from whale watches is usually not retained due to lack of background knowledge prior to the whale watch and frequent distractions (Malcolm & Duffus, 2003), as well as the absence of structured education programs (Stamation, et al., 2007). However, the present study determined that gains can be made in knowledge and awareness from whale watching immediately after and six months after the tour, despite the majority of participants being first-time whale watchers. Furthermore, while the majority of participants in the present study did not correctly identify all of the guidelines and regulations, the percentage of correct responses significantly increased between the PRE vs. POST6M and POST vs. POST6M. Knowledge gains were not immediately apparent after the whale watch, but it may have allowed passengers to be more open to messages about whales and whale watching after the experience.

Across all survey groups, the most important factors in determining the quality of the whale watch were getting close to the whales and seeing interesting behaviors like feed or leap. Awareness of whale watching guidelines/regulations and knowledge of the 100-yard distance regulation did not affect participants' attitudes regarding the importance of getting close to whales. The importance of close encounters and observing interesting behaviors could largely be due to perceptions of whales from the media and the way whale watching is advertised. This study indicated that the majority of PRE participants received their information from TV and movies, which can sometimes feature false perceptions about viewing whales and the behaviors frequently seen. As mentioned by Malcolm and Duffus (2003), people may not realize that movies, TV, and pictures are the result of hundreds of hours of work and that they are often only shot in perfect conditions. Furthermore, whale watching companies will advertise, "Guaranteed Sightings" next to a photo of a breaching whale or a close up of a whale (Malcolm & Duffus, 2003). As seen in the present study, the majority of participants indicated that it was very important for them to personally see humpback whales in the wild. This could also be attributed to the whale sighting guarantee that all Juneau operators offer. Similarly, of participants that were aware of guidelines and regulations, participants that selected the regulation “Maintaining a distance of at least 100 yards from humpback whales” and guideline “Staying with humpback whales for a maximum of 30 minutes” significantly increased between the PRE vs. POST and PRE vs. POST6M. These limitations are likely the most memorable of the guidelines and regulations because they influence passenger viewing experience.

Participants in the present study largely agreed or strongly agreed that “observing whales from boats can have positive impacts on people”, with the percentage that strongly agreed significantly increasing six months later. These results mirror dolphin-swim participant responses in Australia, in which the proportion of passengers that agreed or strongly agreed that “observing dolphins from boats can have a positive impacts on people, grew between the surveys before, after, and six-months after a tour (Filby, et al., 2015). Therefore, the positive impact may be most strongly felt over time. Orams (2000) indicated that the presence of whales alone can positively influence whale watcher satisfaction. Across all survey groups, the majority of participants were neutral in response to “observing whales from boats can have negative impacts on whales”. However, while there was a significant increase from PRE to POST in participants that disagreed that boats have negative impacts on whales, there was a significant increase in participants that agreed six months later. This trend has also been demonstrated in dolphin-swim tourism, in which following a whale watch the percentage of passengers that agreed or strongly agreed that “observing dolphins from boats can have negative impacts on dolphins” decreases following a whale watch, but is highest before and six-months after (Filby, et al., 2015). Furthermore, the majority of participants across all survey groups agreed or strongly agreed that “Following whale watch guidelines and regulations is important for the protection of whales”, and the “Strongly agree” significantly increased between PRE vs. POST and PRE vs. POST6M. Since most wildlife tourists do not desire to cause harm to the environment in which they are visiting (Curtin, 2010; Wiener, Needham, & Wilkinson, 2009), they may be more likely to recognize their possible impact six months later rather than immediately after the whale watch. Additionally, after participants become aware of guidelines and regulations during a whale watch, it is likely that they more positively perceive the existence of guidelines and regulations responsible for reducing negative impacts on whales.

The present study indicated that participants that were aware of whale watching guidelines and regulations were significantly more likely to indicate strong support for guidelines and regulations for the protection of humpback whales than those that were not. This supports findings by Filby, et al. (2015) that as participants become knowledgeable about guidelines and regulations, they are more likely to support them. Participants who are aware of guidelines and regulations are less likely to be dissatisfied with viewing distance (Andersen & Miller, 2006). Operators can better alleviate disappointment and negative perceptions associated with the absence of close encounters by educating passengers about existing guidelines and regulations and why they are in place. Filby, et al. (2015) determined that passengers with knowledge of regulations are more satisfied, and ultimately can positively reinforce tour operator compliance to regulations. By managing expectations of participants and emphasizing conservation messages on trips, participants may be more satisfied with their overall experience. This indicates that operators can follow whale watching guidelines and regulations without risking passenger enjoyment. Also, in regions with low enforcement of regulations, there is a low likelihood of operator adherence to guidelines and regulations (Filby, et al., 2015; Kessler & Harcourt, 2013). In such cases, education can be a useful tool in increasing operator compliance.

NEP was approximately the same between survey groups. Other studies have similarly indicated that over time, pro-environmental attitudes do not increase as a result of ecotourism (Beaumont, 2001). However, participant pro-environmental attitudes largely correlated with attitudes towards whale watching. Participants who indicated importance for operators being respectful to whales and participants with greater concern for the impact of vessels on whales had higher pro-environmental attitudes. Interestingly, in response to “Following whale watch guidelines and regulations is important for the protection of whales”, participants that selected “Neutral” had a significantly lower NEP than those that agreed, but those that disagreed did not have a significantly different NEP than those that agreed. While protection of resources is a fundamental pro-environmental attitude, how people believe it should be protected may vary. The connection between attitudes towards the conservation and protection of whales may not always extend to that of general protection of the environment and vice versa (Stamation, et al., 2007). However, the present study supports results of Christensen, et al. (2009), which indicated that whale watchers that were stronger in their pro-environmental values were more likely to be aware of effects of their behavior on whales and their habitat. The incorporation of social desirability as a control also proved to be an important factor in modeling for pro-environmental values, with SDRS significantly increasing with each unit increase of NEP. Future research is encouraged to include SDRS as a standard in questionnaires to increase quality of self-reported answers.

Following a whale watch, the majority of passengers were very likely to participate in another whale watch and tell friends and family about what they learned. However, participants were "somewhat likely" to join or donate to an environmental or conservation organization. Within six months, participants were unlikely to have gone on another whale watch or ecotourism trip or to have joined or donated to an environmental or conservation organization, but were very likely to have told friends and family about what they learned. This supports other studies that have also indicated that participants are more likely to engage in pro-environmental behaviors that require less commitment regarding effort, time, and/or money (Filby, et al., 2015; Mayes & Richins, 2009). The majority of participants in all survey groups engaged in at least one environmental behavior, with recycling at home being the highest. This reflects the concern of Beaumont (2001), that ecotourism may be just "preaching to the converted" and that little pro-environmental behavioral gain occurs from ecotourism because participants who seek those experiences are already engaging in pro-environmental behaviors.

Other studies argue that while pro-environmental behavioral intentions and environmental knowledge are high after a whale watch, participants were not likely to adopt or maintain these changes when they returned home (Beaumont, 2001; Stamation, et al., 2007). Some pro-environmental behaviors may have barriers for adoption such as lack of knowledge on how to adopt, level of effort necessary (Pearson, et al., 2012), or it is not possible to adopt (i.e., recycling at work). In order to change behavior, Orams (1997) indicates that educational programs must be structured to do so. Whale watching programs should be encouraged to develop programs that motivate participants to adopt pro-environmental behaviors (Packer & Ballantyne, 2012). The likelihood of participants supporting the protection of marine mammals increases when conservation messages and actions are incorporated into the whale watching tour (Zeppel & Muloin, 2009). The most effective way to enable participants to engage in conservation actions is to provide opportunities to take action on the trip itself (Orams, 1997).

All companies in which participants were surveyed belonged to the Whale SENSE program, indicating that their staff had received additional training and had agreed to abide by additional guidelines. In comparison to a preliminary study conducted by Lopez and Pearson (2017) of the Juneau whale watching industry prior to the inception of Whale SENSE in 2015, awareness of whale watch guidelines and regulations increased from 49% to 71%. While the previous study did not measure the long-term effects, the present study also suggested an additional increase six-months later (85%). This could indicate that the implementation of the Whale SENSE program has fostered increases in participant awareness of guidelines and regulations. However, after a whale watching tour in both studies, the majority of participants indicated that their whale watch was their primary source of information about whales, that most participants were very likely to go on another whale watch or tell friends and family about what they learned, and that the primary factors of importance were getting close to the whales and seeing interesting behaviors like feed or leap.

The importance of close encounters in Lopez and Pearson (2017) and the present study supports the finding in this study that awareness about guidelines and regulations and knowledge about whales alone is not enough to influence the importance of getting close to whales for participants. It will be important to evaluate the quality of information being presented about the purpose of regulations and guidelines on Whale SENSE whale watching tours to determine aspects that could be improved for training. However, as determined in the present study, the majority of whale watching participants indicated close encounters as the single most important factor in their whale watch before even going on the whale watch. Therefore, an important consideration for operators is to better manage expectations before participants begin their whale watch. In order to be considered a participant in the program, Whale

SENSE requires that operators "Engage in responsible advertising that does not depict illegal behavior & informs viewers of responsible viewing practices, and NOAA Fisheries Alaska Humpback Whale Approach Regulations, and whale watching guidelines" (NOAA Fisheries & Whale and Dolphin Conservation, 2018). Ultimately, by using media that better reflects compliance with guidelines and regulations and incorporating educational messages into advertisements, operators can better support conservation messages and responsible viewing practices.

5. Conclusions

As whale watch tourism continues to grow in Juneau and throughout the world, incorporating education and conservation into the participant experience will be increasingly important. Participants in this study demonstrated that whale watching can increase awareness, knowledge, and support of whale watching guidelines and regulations. By managing expectations for close encounters with whales through education, operators can be encouraged to abide by guidelines and regulations without sacrificing participant satisfaction. The implementation of voluntary programs, such as Whale SENSE, has shown promise in encouraging participant awareness about whales and whale watching. Therefore, structured and comprehensive educational programs can be used to better support management objectives seeking to conserve and protect whales and their environment. This study indicates that educational programs on whale watching tours should be considered as a management tool in encouraging operator compliance.

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Figures

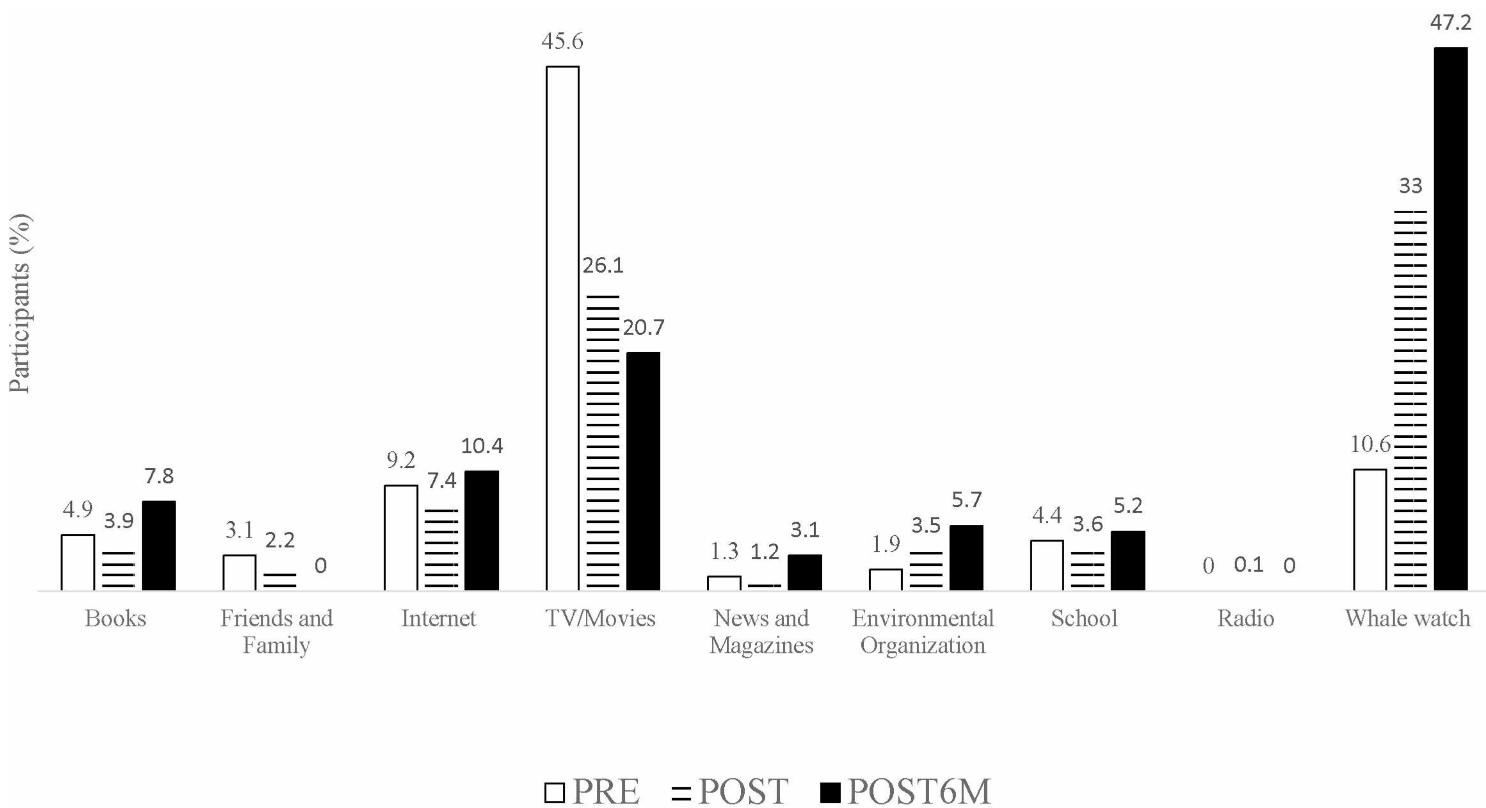

Figure 2.1. Distribution of passenger selected sources in response to the multiple answer choice question, "How have you gained most of your knowledge about whales?" Percentages are presented above each bar (PRE: hollow bar, POST: hatched bar, POST6M: solid bar).

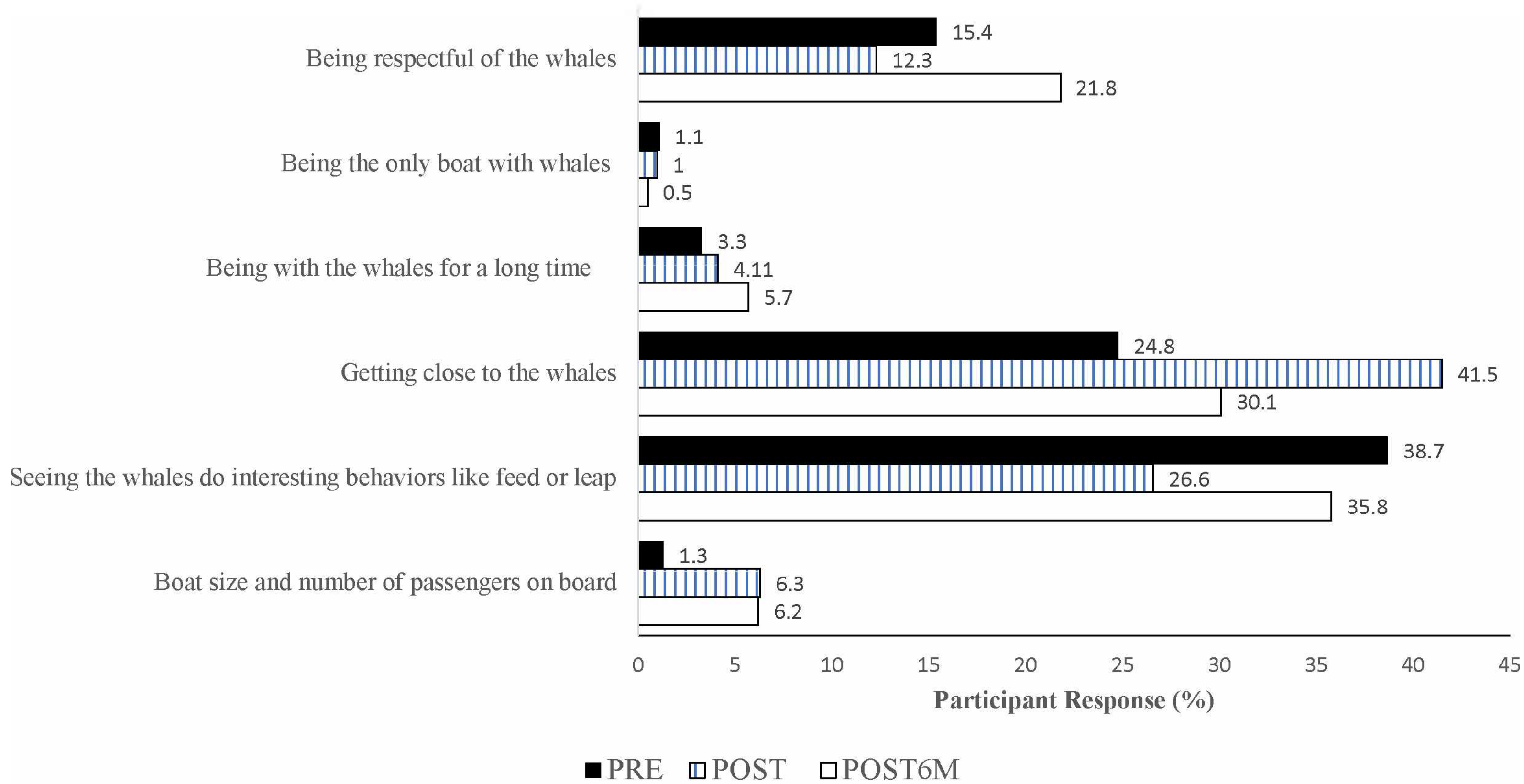

Figure 2.2. Passenger responses to the multiple answer choice question, "Which of the following do you think will be/was the single most important factor in determining the quality of your whale watch experience?" Percentages are presented next to each bar. (PRE: hollow bar, POST: hatched bar, POST6M: solid bar)

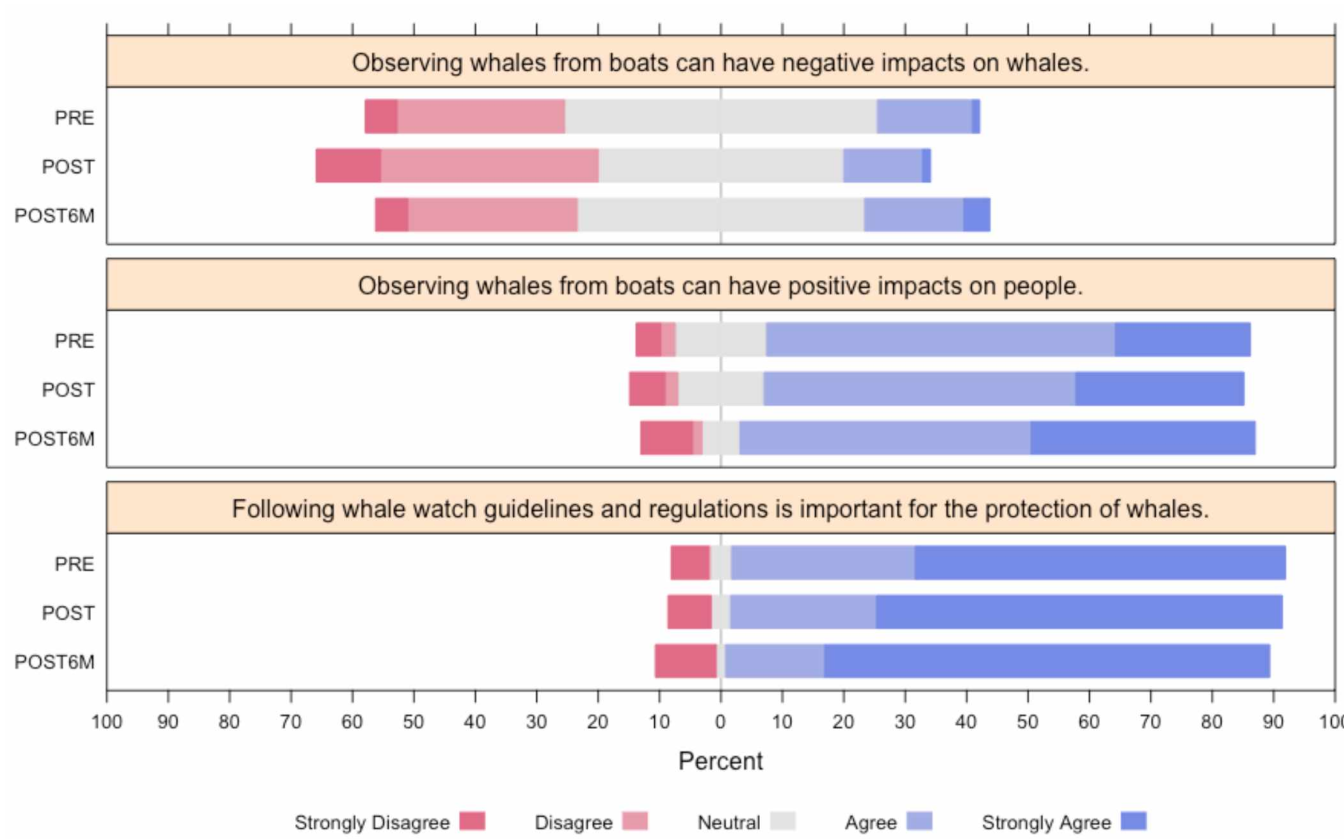

Figure 2.3: Participant`s attitudes regarding whale watching on a Likert-type scale. (PRE: N=963, POST: N=1136, POST6M: N=192).

Tables

Table 2.1. Passenger responses to the demographic questions on the multiple answer choice survey (PRE and POST, N=2,138). Totals that do not equal 100% or N=2,138 reflect missing data.

Survey Item			*% (n)*
Age	18-25		6.3 (135)
	26-40		18.0 (384)
	41-60		42.1 (901)
	60+		30.1 (643)
Sex	Female		54.6 (1168)
	Male		35.0 (748)
Nationality	USA		80.8 (1727)
	Other		16.7 (358)
		Europe	*4.3 (94)*
		Australia/New Zealand	*4.2 (89)*
		Canada	*3.4 (72)*
		Asia	*2.1(46)*

Table 2.2. Participant responses to questions regarding knowledge about guidelines and regulations (PRE: N=971, POST: N=1167, POST6M: N=193).

	PRE % (n)	PRE-POST	POST % (n)	POST-POST6M	POST6M % (n)	PRE-POST6M
Are you aware of NOAA whale watch guidelines? (Yes)	35.6 (344)	↑***	71.0 (828)	↑*	85.0 (164)	↑***
If yes, check the items that you think are part of the NOAA guidelines:						
Maintaining a distance of at least 100 yards from humpback whales	77.0 (265)	↑**	93.0 (770)	↓	89.3 (147)	↑**
Staying with humpback whales for a maximum of 30 minutes	22.7 (78)	↑*	38.0 (315)	↑	43.9 (72)	↑*
Not encircling or trapping humpback whales between boats, or boats and shore	67.7 (233)	↓	61.6 (510)	↑***	82.3 (135)	↑***
Operating vessels at slow, safe speeds when near humpback whales	61.9 (213)	↑	63.0 (522)	0	63.2 (107)	↑
Do not disrupt the normal behavior or prior activity of a whale [a]	55.2 (190)	↓	45.3 (375)	↑	62.2 (102)	↑
If selected "yes", participants correctly selected all guidelines/regulations.	18.9 (65)	↓	11.7 (97)	↑***	36.6 (60)	↑**

* p-value= 0.01-0.05, ** p-value = 0.001-0.01, ***p-value < 0.001
↑ = increase between survey groups; ↓ = decrease between survey groups
[a] Additional component of the regulation added in 2017

Table 2.3. Intention following whale watching trip. Totals that do not equal 100% or N=1167 (POST), N=193 (POST6M) reflect missing data.

After your whale watch in Juneau, how likely would you be to:		After your whale watch in Juneau, did you:		"Very Likely" vs. "Yes"
POST	%	POST6M	%	POST-POST6M
Go on another whale watch or marine ecotourism trip?				
Very Likely	67.2 (784)	Yes	6.2 (12)	↓***
Somewhat Likely	26.8 (313)	No	93.3 (180)	
Not Likely	5.5 (64)			
Join or donate to an environmental or conservation organization?				
Very Likely	23.3 (272)	Yes	11.9 (23)	↓*
Somewhat Likely	50.0 (583)	No	87.0 (168)	
Not Likely	23.0 (268)			
Tell your friends and family about what you learned?				
Very Likely	80.4 (938)	Yes	94.3 (182)	↑*
Somewhat Likely	15.4 (180)	No	5.7 (11)	
Not Likely	1.5 (18)			
* p-value= 0.01-0.05, ** p-value = 0.001-0.01, ***p-value < 0.001				

Table 2.4. POST and POST6M participants' intention according to previous whale watch (WW) experience. Totals that do not equal 100% or N=1167 (POST), N=193 (POST6M) reflect missing data.

		First WW %(n)	**≥ 1 WW %(n)**	**Pearson X2**	**df**	***P***
After your whale watch in Juneau, how likely would you be to: (POST)						
Go on another whale watch or marine ecotourism trip?	Very Likely	61.4 (461)	77.6 (323)	5.8667	2	0.053
	Somewhat Likely	31.4 (236)	18.5 (77)			
	Not Likely	6.4 (48)	3.9 (16)			
Join or donate to an environmental or conservation organization?	Very Likely	22.5 (169)	24.8 (103)	0.25412	2	0.881
	Somewhat Likely	49.4 (371)	51.0 (212)			
	Not Likely	23.8 (179)	21.4 (89)			
Tell your friends and family about what you learned?	Very Likely	80.2 (602)	80.8 (336)	0.27636	2	0.871
	Somewhat Likely	15.6 (117)	15.1 (63)			
	Not Likely	1.2 (9)	2.2 (9)			
After your whale watch in Juneau, did you: (POST6M)						
Go on another whale watch or marine ecotourism trip?	Yes	0.0 (0)	13.8 (12)	12.906	1	*<0.001*
	No	100.0 (106)	85.1 (74)			
Join or donate to an environmental or conservation organization?	Yes	10.4 (11)	13.8 (12)	0.34143	1	0.559
	No	89.6 (95)	83.9 (73)			
Tell your friends and family about what you learned?	Yes	95.3 (106)	93.1 (81)	0.12722	1	0.721
	No	4.7 (5)	6.9 (6)			

Table 2.5. Passenger responses to "Which of the following environmental activities do you do? Check all that apply."

	PRE %(n)	POST %(n)	POST-POST6M	POST6M %(n)	PRE-POST6M
Recycle at home	80.0 (777)	83.3 (972)	↑	86.5 (167)	↑
Recycle at work	51.3 (498)	53.9 (629)	↑	59.1 (114)	↑
Conserve energy at home	70.7 (686)	74.7 (872)	↑	83.9 (162)	↑*
Vegetarianism	4.7 (46)	6.3 (74)	↓	4.2 (8)	0
Avoid cosmetics tested on animals	24.2 (235)	25.2 (294)	↑	30.6 (59)	↑
Avoid using the car when possible	17.0 (165)	19.7 (230)	↑	27.5 (53)	↑
Compost	16.4 (159)	21.6 (252)	↑	25.9(50	↑
Belong to an environmental or conservation organization	7.3 (71)	9.9 (116)	↑	13.5 (26)	↑
None of the above	5.0 (48)	3.9 (45)	↓	0.5 (1)	↓

* $p<0.05$.

Table 2.6. Logistic regression output for predicting the probability of participants selecting “strongly agree” vs. “other” responses (strongly disagree, disagree, neutral, agree) to “Following whale watch guidelines and regulations is important for the protection of humpback whales”. Predictor variables included awareness of regulations and guidelines, attitudes towards whale watching, pro-environmental attitudes (NEP), and demographics (nationality, sex, age), while controlling for SDRS.

	Estimate	Std. Error	z value	Pr(>|z|)
(Intercept)	-2.010	0.485	-4.146	*<0.001*
Awareness of Regulations: No	Ref	Ref	Ref	Ref
Awareness of Regulations: Yes	0.378	0.080	4.749	*<0.001*
Belong to an organization - No	Ref	Ref	Ref	Ref
Belong to an organization - Yes	0.202	0.213	0.948	0.343
Importance Factor: Getting Close	Ref	Ref	Ref	Ref
Importance Factor: Boat Size	0.430	0.278	1.546	0.122
Importance Factor: See behaviors like feed or leap	0.003	0.125	0.021	0.983
Importance Factor: Long time with whales	-0.086	0.268	-0.321	0.748
Importance Factor: Only boat	0.081	0.504	0.161	0.872
Importance Factor: Being respectful to whales	0.366	0.180	2.029	*0.042*
See whales in the wild - Very Important	Ref	Ref	Ref	Ref
See whales in the wild - Somewhat Important	-0.518	0.117	-4.428	*<0.001*
See whales in the wild - Not Important	-0.350	0.268	-1.305	0.192
Boats have negative effects - Agree	Ref	Ref	Ref	Ref
Boat have negative effects - Neutral	-0.379	0.176	-2.152	*0.031*
Boat have negative effects - Disagree	-0.432	0.179	-2.412	*0.016*
NEP	0.137	0.015	9.059	*<0.001*
SDRS	0.014	0.042	0.343	0.731
Nationality - Other	Ref	Ref	Ref	Ref
Nationality - USA	0.432	0.156	2.766	*0.006*
Sex - Female	Ref	Ref	Ref	Ref
Sex - Male	-0.262	0.112	-2.334	*0.020*
Age: 18-25	Ref	Ref	Ref	Ref
Age: 26-40	-0.254	0.262	-0.970	0.332
Age: 41-60	-0.415	0.244	-1.705	0.088
Age: 60+	-0.562	0.250	-2.252	*0.024*

Significant p-values are in Italic type
Ref = reference group in the analysis

Table 2.7. Linear modelling output for pro-environmental attitudes (NEP value) including predictor variables of behavior ("Recycle at home" and "Belong to an environmental or conservation organization") and attitudes towards whale watching, while controlling for SDRS and demographics (nationality, sex).

	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	24.224	0.416	58.289	*<0.001*
Recycle - No	Ref	Ref	Ref	Ref
Recycle - Yes	0.826	0.238	3.478	*0.001*
Belong to an organization - No	Ref	Ref	Ref	Ref
Belong to an organization - Yes	1.724	0.306	5.626	*<0.001*
Importance Factor: Getting Close	Ref	Ref	Ref	Ref
Importance Factor: Boat Size	0.452	0.425	1.063	0.288
Importance Factor: See behaviors like feed or leap	0.217	0.207	1.051	0.293
Importance Factor: Long time with whales	0.069	0.444	0.154	0.877
Importance Factor: Only boat	0.370	0.819	0.452	0.651
Importance Factor: Being respectful to whales	1.483	0.271	5.466	*<0.001*
See whales in the wild - Very Important	Ref	Ref	Ref	Ref
See whales in the wild - Somewhat Important	-0.712	0.311	-2.290	*0.022*
See whales in the wild - Not Important	0.166	0.220	0.753	0.451
Boats have negative effects - Agree	Ref	Ref	Ref	Ref
Boat have negative effects - Neutral	-0.663	0.264	-2.511	*0.012*
Boat have negative effects - Disagree	-0.823	0.268	-3.067	*0.002*
Regulations important - Agree	Ref	Ref	Ref	Ref
Regulations important - Neutral	-2.816	0.540	-5.213	*<0.001*
Regulations important - Disagree	-0.102	0.248	-0.411	0.681
SDRS	0.177	0.067	2.646	*0.008*
Nationality - Other	Ref	Ref	Ref	Ref
Nationality - USA	-1.628	0.248	-6.550	*<0.001*
Sex - Female	Ref	Ref	Ref	Ref
Sex - Male	-0.592	0.184	-3.223	*0.001*

Significant p-values are in Italic type
Ref = reference group in the analysis

General Conclusions

The whale watching industry in Juneau, Alaska has grown alongside increasing humpback whale populations (Hendrix et al., 2012) and growing cruise ship tourism (Rain Coast Data, 2018). The overall goal of the present study was to understand how whale watching vessel presence may affect humpback whales and whether whale watching can provide conservation benefits through the passenger experience. By looking at the possible impacts on both whales and people, this study provides a holistic perspective on improvements that can be made by management to ensure the sustainability of the industry.

In Chapter 1, the effects of whale watching vessels on humpback whale movements and behavior were evaluated. By collecting shore-based behavioral observations and obtaining location measurements from shore using a theodolite, data could be collected without increasing vessel pressure on the whales. Compared to the absence of vessels, humpback whales in the presence of vessels had increased deviation, higher speed, and decreased inter-breath intervals (IBI). Furthermore, for each additional vessel present, deviation increased and IBI decreased. These detectable differences suggest that the presence of whale watching vessels and number of vessels does influence humpback whale movement and behavior. Because humpback whales can be exposed to vessels frequently and for long periods of time while in the tour area, the detected effects could have cumulative consequences. This is supported in the present study that respiration rate increased with time spent in the presence of vessels. Feeding and traveling humpback whales were likely to maintain their behavioral state regardless of vessel presence, while surface active humpback whales were likely to transition to traveling in the presence of vessels. Therefore, the need to build energy reserves while on the feeding grounds may supersede ceasing that behavior even if disturbed.

The results of the present study call into question the effectiveness of current guidelines and regulations currently in place to prevent the "take" of humpback whales. Humpback whale changes in deviation, speed, and IBI in the presence of vessels could violate the current regulations, including to "not disrupt the normal behavior or prior activity of a whale" (National Oceanic and Atmospheric

Administration, 2001). Furthermore, as the number of vessels has been determined as an influencing factor, restricting the maximum number of vessels around whales or limits to the number of vessels in the industry would be an important consideration for managers.

Management strategies to control the number of vessels watching whales in other areas has varied from voluntary guidelines to limited entry. In the United States, NOAA Fisheries in the Greater Atlantic Region has already created guidelines limiting the number of vessels that can approach whales at designated distance thresholds. (NOAA Fisheries Greater Atlantic Region, 2018). Examples of more formal limitations exist in South Africa, New Zealand, and Spain, where whale watching business permits are issued (Carlson, 2010). In South Africa, total duration of contact with whales within 300 meters is restricted to 30 minutes and operators are required to limit approaching the same whale group to only twice a day, with a minimum of 3 hours between visits (Carlson, 2010). Furthermore, a three vessel maximum is permitted within 300 meters of bottlenose dolphin (*Tursiops truncatus*) groups in Doubtful Sound, New Zealand (New Zealand Department of Conservation, n.d.) and within 200 meters of any cetacean in Canary Islands, Spain.

Several studies have indicated that industry-wide inconsistencies and low compliance with government issued regulations can reduce their efficacy (Kessler and Harcourt, 2013; Meissner et al., 2015). Noncompliance can also reduce the strength of voluntary whale watching codes of conduct (Wiley et al., 2008). Because the lack of resources can often be an obstacle for governing bodies, self-regulation is often considered a viable alternative. However, most research suggests that the industry must take ownership of the changes in order for them to be fully effective (Hoyt and Parsons, 2014). Recognition programs, such as Whale SENSE (NOAA Fisheries and Whale and Dolphin Conservation, 2018), may serve as a means to increase accountability, as operators publicly agree to follow best practices in return for the marketing value of an eco-label.

The long-term impacts of the growing industry are still not fully understood. However, if this industry in Juneau is not managed properly, there is concern that the profitability of the whale watching industry could be jeopardized if vessel presence influences the distribution and health of humpback whales. Cumulative increases in energetic expenditure from increases in deviation and speed in the presence of vessels may cause physical fitness decline in whales (Beale, 2007). If extreme enough, these physiological consequences could decrease reproductive success or longevity (Bejder and Samuels, 2003). However, chronic stress has not been detected in whales within the tour area. Specifically, compared to more remote areas, humpback whales in the Juneau tour area have not exhibited higher levels of the stress hormone, cortisol (Teerlink et al., 2018). The present study determined that humpback whales will continue feeding, regardless of vessel presence. Therefore, the continuation of essential body maintenance behaviors, such as foraging, may allow humpback whales to continue acquiring essential energy reserves, despite the disturbance of vessel presence.

In Chapter 2, conservation benefits of whale watching were assessed by measuring passenger knowledge, intentions, behaviors, and attitudes using surveys before, immediately after, and 6 months after a whale-watching tour. By using surveys from different time periods surrounding the whale watching experience, comparisons could be made in the short-term and long-term. Participants in this study demonstrated that whale watching can increase awareness, knowledge, and strong support of whale watching guidelines and regulations. Strong support of guidelines/regulations were more likely if participants were aware of guidelines/regulations and less likely if participants disagreed that boats have a negative impact on whales (vs. agreed). Participants that acknowledged human impacts on whales and their habitat had stronger pro-environmental attitudes.

While conservation gains were indicated by increases in participant knowledge, awareness and attitudes regarding whales and whale watching guidelines/regulations over time, participants did not indicate long-term changes in behavior and overall pro-environmental attitudes. The majority of participants in all survey groups already practiced at least one pro-environmental behavior (e.g. recycling at home). Therefore, little pro-environmental behavioral gain may occur in whale watching participants because those who go on whale watching tours are already engaging in pro-environmental behaviors. However, studies suggest that in order to inspire conservation action, programs must be developed to directly address specific conservation issues regarding the protection of marine mammals and identify desired related behaviors (Orams, 1997; Zeppel and Muloin, 2009; Packer and Ballantyne, 2012). Overall, participants in this study were likely to have told their friends and family about what they learned, but less likely to have joined or donated to an environmental or conservation organization. However, approximately a quarter of participants said they were very likely, and half were somewhat likely, to join or donate to an environmental or conservation organization immediately following their whale watch. Therefore, as participants are less likely to adopt pro-environmental behaviors that require more commitment regarding effort, time, and/or money (Mayes and Richins, 2009, Filby et al., 2015), providing a means to enable participants to engage in conservation actions (e.g., join or donate to efforts dedicated to protecting whales) is to take action on the trip itself (Orams, 1997).

The Whale SENSE program provides training and educational opportunities for operators in Juneau. In comparison to a preliminary study conducted by Lopez and Pearson (2017) of the Juneau whale watching industry prior to the inception of Whale SENSE in 2015, awareness of whale watch guidelines and regulations increased. However, in both studies, getting close to whales remained an important factor in a participant's whale watch. This is of particular concern because NOAA guidelines and regulations prohibit approaches within 100 yards, and participant expectations may pressure operators to not comply in order to satisfy customers. Ultimately, the desire for close encounters may originate from TV and movies, where the majority of participants in this study received their information about whales prior to the whale watch. Furthermore, the importance of close encounters may largely be due to perceptions of whales from the media and the way whale watching is advertised (Malcolm and Duffus, 2003). Marketing efforts to highlight extraordinary behaviors and encounters can contribute to unrealistic expectations for participants.

Whale watching operators can better manage expectations of participants through modifying advertising messages and providing detailed information about the purpose of guidelines and regulations. Whale SENSE supports this effort by requiring that participating operators "Engage in responsible advertising that does not depict illegal behavior & informs viewers of responsible viewing practices, and NOAA Fisheries Alaska Humpback Whale Approach Regulations, and whale watching guidelines"

(NOAA Fisheries and Whale and Dolphin Conservation, 2018). Responsible advertising would support conservation by setting expectations for participants that better reflects compliance with guidelines and regulations. Furthermore, participants in this study that are aware of whale watching guidelines and regulations were significantly more likely to indicate strong support for guidelines and regulations for the protection of humpback whales than those that were not. By educating participants about existing guidelines and regulations and why they are in place, operators can better alleviate disappointment and increase guest satisfaction. Other studies have supported these results determined that passengers with knowledge of regulations are more satisfied with viewing distance (Andersen and Miller, 2006), and ultimately can positively reinforce tour operator compliance to regulations (Filby et al., 2015). Therefore, management objectives in support of whale conservation can use educational programs on whale watching tours as a management tool to bolster operator compliance.

Future work on the effects of whale watching in Juneau should focus on the effectiveness of current management measures, effects of cumulative exposure to vessels, and the evaluation of educational programs in place. In order to better understand if the approach regulations are sufficient to prevent disturbance of humpback whales in the tour area, a study should be conducted to evaluate whale responses to vessels at different distance thresholds. Furthermore, little is known more concerning the acoustic disturbance from vessels on humpback whales (Erbe, 2002). Studies focusing on acoustic thresholds could help determine how different engine types and positions, vessel size, number of vessels, and environmental conditions (i.e. narrow passageways) affect whales. The growing industry can then be advised on vessels and practices that produce the least acoustic impact. It is also important to continue to investigate the long-term impacts of vessel disturbance, both the physiological effects on individuals and changes in overall distribution. While the North Pacific humpback whale population have increased over the last decade (Muto et al., 2017), non-carrying capacity related declines in humpback whale abundance has occurred in nearby Glacier Bay (Neilson et al., 2018). Stressors beyond vessel presence, such as prey availability, should also be investigated in relation to humpback whale health and distribution. Furthermore, evaluating compliance with Whale SENSE operators and other vessels would help the industry to determine whether the regulations should be revised or vessel behavior should be improved. To further support developing educational programs as a management tool, obtaining additional information regarding whale watching passenger knowledge and motivation for going on a whale watching tour would aid in honing the messages to the proper audience. Furthermore, evaluation of interpretation onboard whale watching vessels would provide more insight into what messages participants are receiving.

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Appendix

Appendix 1-A: Linear mixed effects models with random effects showing the effect of 1) vessel presence 2) number of vessels (linear) and 3) number of vessels (categorical) on reorientation (n = 2,952 fixes), speed (n=3,136 fixes), and inter-breath interval (IBI) (n = 5,396 observations), while controlling for behavioral state, time, Julian date, year, location, distance from site, time between fixes, and dive type.

Metric	Vessel Presence				Number of Vessels (Linear)				Number of Vessels (Categorical)			
		Value	Std.Error	p-value		Value	Std.Error	p-value		Value	Std.Error	p-value
log(Deviation)	(Intercept)	2.806	0.323	*<0.001*	(Intercept)	2.989	0.321	*<0.001*	(Intercept)	2.847	0.325	*<0.001*
	Behavioral State: Travelling	Ref	Ref	Ref	Behavioral State: Travelling	Ref	Ref	Ref	Behavioral State: Travelling	Ref	Ref	Ref
	Behavioral State: Feeding	0.602	0.090	*<0.001*	Behavioral State: Feeding	0.596	0.091	*<0.001*	Behavioral State: Feeding	0.611	0.091	*<0.001*
	Behavioral State: Resting	-0.860	0.364	*0.018*	Behavioral State: Resting	-0.793	0.366	0.030	Behavioral State: Resting	-0.862	0.365	*0.018*
	Behavioral State: Surface active	0.489	0.453	0.281	Behavioral State: Surface active	0.432	0.455	0.342	Behavioral State: Surface active	0.476	0.454	0.294
	Location: Point Lena	Ref	Ref	Ref	Location: Point Lena	Ref	Ref	Ref	Location: Point Lena	Ref	Ref	Ref
	Location: Point Retreat	0.563	0.098	*<0.001*	Location: Point Retreat	0.582	0.099	*<0.001*	Location: Point Retreat	0.565	0.099	*<0.001*
	Julian Date	-0.006	0.002	*<0.001*	Julian Date	-0.007	0.002	*<0.001*	Julian Date	-0.006	0.002	*<0.001*
	Distance from site	0.000	0.000	*<0.001*	Distance from site	0.000	0.000	*<0.001*	Distance from site	0.000	0.000	*<0.001*
	Time between fixes	0.059	0.007	*<0.001*	Time between fixes	0.060	0.007	*<0.001*	Time between fixes	0.059	0.007	*<0.001*
	Boat Presence: Absence	Ref	Ref	Ref	Number of Vessels	0.060	0.025	*0.017*	Number of Vessels: 0	Ref	Ref	Ref
	Boat Presence: Presence	0.329	0.077	*<0.001*					Number of Vessels: 1	0.355	0.095	*<0.001*
									Number of Vessels: 2	0.372	0.118	*0.002*
									Number of Vessels: 3	0.364	0.148	*0.014*
									Number of Vessels: 4	0.112	0.166	0.503
									Number of Vessels: 5	0.056	0.218	0.797
									Number of Vessels: 6	0.390	0.311	0.210
									Number of Vessels: 7	0.336	0.520	0.517
									Number of Vessels: 8	0.855	0.559	0.126
sqrt(Speed)	(Intercept)	2.265	0.053	*<0.001*	(Intercept)	2.271	0.052	*<0.001*	(Intercept)	2.259	0.052	*<0.001*
	Behavioral State: Travelling	Ref	Ref	Ref	Behavioral State: Travelling	Ref	Ref	Ref	Behavioral State: Travelling	Ref	Ref	Ref
	Behavioral State: Feeding	-0.036	0.036	0.310	Behavioral State: Feeding	-0.038	0.036	0.293	Behavioral State: Feeding	-0.030	0.036	0.403
	Behavioral State: Resting	-0.528	0.146	*<0.001*	Behavioral State: Resting	-0.513	0.145	*<0.001*	Behavioral State: Resting	-0.535	0.145	*<0.001*
	Behavioral State: Surface active	-0.285	0.179	0.110	Behavioral State: Surface active	-0.299	0.178	0.093	Behavioral State: Surface active	-0.285	0.178	0.108
	Year: 2016	Ref	Ref	Ref	Year: 2016	Ref	Ref	Ref	Year: 2016	Ref	Ref	Ref
	Year: 2017	-0.100	0.051	0.051	Year: 2017	-0.095	0.050	0.062	Year: 2017	-0.097	0.050	0.054
	Location: Point Lena	Ref	Ref	Ref	Location: Point Lena	Ref	Ref	Ref	Location: Point Lena	Ref	Ref	Ref
	Location: Point Retreat	-0.068	0.041	0.099	Location: Point Retreat	-0.069	0.041	0.093	Location: Point Retreat	-0.063	0.041	0.124
	Distance from site	0.000	0.000	*0.001*	Distance from site	0.000	0.000	*0.001*	Distance from site	0.000	0.000	*<0.001*
	Boat Presence: Absence	Ref	Ref	Ref	Number of Vessels	0.011	0.010	0.266	Number of Vessels: 0	Ref	Ref	Ref
	Boat Presence: Presence	0.060	0.030	*0.048*					Number of Vessels: 1	0.072	0.036	*0.047*
									Number of Vessels: 2	0.089	0.045	*0.049*
									Number of Vessels: 3	-0.075	0.057	0.185
									Number of Vessels: 4	0.058	0.065	0.371
									Number of Vessels: 5	0.104	0.087	0.230
									Number of Vessels: 6	0.069	0.137	0.615
									Number of Vessels: 7	-0.053	0.193	0.783
									Number of Vessels: 8	0.367	0.263	0.163
log(IBI)	(Intercept)	5.425	0.284	*<0.001*	(Intercept)	5.352	0.285	*<0.001*	(Intercept)	5.289	0.290	*<0.001*
	Behavioral State: Travelling	Ref	Ref	Ref	Behavioral State: Travelling	Ref	Ref	Ref	Behavioral State: Travelling	Ref	Ref	Ref
	Behavioral State: Feeding	-0.016	0.039	0.686	Behavioral State: Feeding	-0.010	0.039	0.808	Behavioral State: Feeding	-0.009	0.039	0.820
	Behavioral State: Resting	0.456	0.168	*0.007*	Behavioral State: Resting	0.448	0.167	*0.008*	Behavioral State: Resting	0.447	0.168	*0.008*
	Behavioral State: Surface active	-0.358	0.175	*0.041*	Behavioral State: Surface active	-0.345	0.174	*0.048*	Behavioral State: Surface active	-0.352	0.175	*0.044*
	Time	0.437	0.150	*0.004*	Time	0.460	0.150	*0.002*	Time	0.481	0.151	*0.001*
	Julian Date	0.005	0.001	*<0.001*	Julian Date	0.005	0.001	*<0.001*	Julian Date	0.005	0.001	*<0.001*
	Year: 2016	Ref	Ref	Ref	Year: 2016	Ref	Ref	Ref	Year: 2016	Ref	Ref	Ref
	Year: 2017	-0.222	0.100	*0.027*	Year: 2017	-0.212	0.100	*0.035*	Year: 2017	-0.205	0.100	*0.043*
	Location: Point Lena	Ref	Ref	Ref	Location: Point Lena	Ref	Ref	Ref	Location: Point Lena	Ref	Ref	Ref
	Location: Point Retreat	-0.427	0.068	*<0.001*	Location: Point Retreat	-0.421	0.068	0.000	Location: Point Retreat	-0.425	0.069	*<0.001*
	Dive Type: Fluke Up	Ref	Ref	Ref	Dive Type: Fluke Up	Ref	Ref	Ref	Dive Type: Fluke Up	Ref	Ref	Ref
	Dive Type: No fluke	-2.375	0.036	*<0.001*	Dive Type: No fluke	-2.375	0.036	*<0.001*	Dive Type: No fluke	-2.374	0.036	*<0.001*
	Vessel Absence	Ref	Ref	Ref	Number of Vessels	-0.035	0.011	*<0.001*	Number of Vessels: 0	Ref	Ref	Ref
	Vessel Presence	-0.069	0.031	*0.025*					Number of Vessels: 1	-0.047	0.036	0.186
									Number of Vessels: 2	-0.063	0.047	0.178
									Number of Vessels: 3	-0.091	0.059	0.125
									Number of Vessels: 4	-0.081	0.067	0.225
									Number of Vessels: 5	-0.176	0.092	*0.054*
									Number of Vessels: 6	-0.343	0.136	*0.012*
									Number of Vessels: 7	-0.244	0.203	0.229
									Number of Vessels: 8	-0.418	0.242	0.085

Significant p-values are in Italic type
Ref = reference group in the analysis

Appendix 2-A: "PRE" survey distributed to whale watching participants before going on a whale watching tour

This survey is voluntary and will only take a couple of minutes. We would like to see what you think about whales, whale-watching, and the environment. All information given is totally confidential, and your personal details will not be used or released to any sources

Nationality/State: ______________________ **Age**: □ 18-25 □ 26-40 □ 41-60 □ over 60
Sex: □ Male □ Female **Race/ethnicity:** _________________

1) How many times have you been whale watching? __________________________

2) How have you gained most of your knowledge about whales? Please select only <u>ONE</u> answer.
□ TV/movies □ Books □ Internet □ Radio □ Newspapers or magazines
□ School □ Family and friends □ Environmental organization □ Whale watches

3) Which of the following do you think will be the <u>single most important</u> factor in determining the quality of your whale watch experience? □ getting close to the whales □ being the only boat with the whales
□ being respectful of the whales □ being with the whales for a long time
□ seeing the whales do interesting behaviors like feed or leap □ boat size and number of passengers on board

4) How important is it *to you personally* to be able to see humpback whales in the wild?
□ very important □ somewhat important □ not important

5) Are you aware of any whale-watch guidelines/regulations? □ Yes □ No
<u>If yes</u>, check the items that you think are part of the guidelines/regulations:
□ Maintaining a distance of at least 100 yards from the whales.
□ Staying with a whale for a maximum of 30 minutes.
□ Not encircling or trapping whales between boats, or boats and shore.
□ If approached by a whale, the engine should be put in neutral and allow the whale to pass.
□ Do not disrupt the normal behavior or prior activity of a whale[5]

6) Which of the following environmental activities do you do? Check all that apply.
□ Recycle at home □ Recycle at work □ Conserve energy use at home □ Vegetarianism
□ Avoid cosmetics tested on animals □ Avoid using the car when possible □ Compost
□ Belong to an environmental organization or charity □ Other _________________ □ None of the above

Please indicate your agreement or disagreement with the following statements about whale watching.
7) Observing whales from boats can have negative impacts on whales.
□ Strongly disagree □ Disagree □ Neither agree nor disagree □ Agree □ Strongly agree

8) Observing whales from boats can have positive impacts on people.
□ Strongly disagree □ Disagree □ Neither agree nor disagree □ Agree □ Strongly agree

9) Following whale watch guidelines and regulations is important for the protection of whales.
□ Strongly disagree □ Disagree □ Neither agree nor disagree □ Agree □ Strongly agree

[5] Added to NOAA's Humpback Whale Approach Regulations in 2017

Please indicate your agreement or disagreement with the following statements about nature. (circle the letters)

	Strongly Agree	Agree	No Opinion	Disagree	Strongly Disagree
10) The balance of nature is very delicate and easily upset	SA	A	N	D	SD
11) Humans must live in harmony with nature in order to survive	SA	A	N	D	SD
12) When humans interfere with nature it often produces disastrous results	SA	A	N	D	SD
13) Humans are destined to rule over the rest of nature	SA	A	N	D	SD
14) Plants and animals exist primarily to be used by humans	SA	A	N	D	SD
15) Humans have the right to modify the natural environment to suit their needs	SA	A	N	D	SD

Finally, we would like you to respond to a few statements about your relationships with others. How much is each statement TRUE or FALSE for you?

	Definitely True	Mostly True	Don't Know	Mostly False	Definitely False
16) I am always courteous even to people who are disagreeable.	1	2	3	4	5
17) There have been occasions when I took advantage of someone.	1	2	3	4	5
18) I sometimes try to get even rather than forgive and forget.	1	2	3	4	5
19) I sometimes feel resentful when I don't get my way.	1	2	3	4	5
20) No matter who I'm talking to, I'm always a good listener.	1	2	3	4	5

Please provide your email address to be entered to win a $50 Amazon gift card and to receive an invitation to participate in a follow-up survey.

____

Thank-you!

For information contact:

Master's Student Ali Schuler, University of Alaska Fairbanks, arschuler@alaska.edu
Principal Investigator Dr. Heidi Pearson, University of Alaska Southeast, hcpearson@alaska.edu, 907-796-6271

Appendix 2-B: "POST" survey distributed to whale watching participants immediately after on a whale watching tour

This survey is voluntary and will only take a couple of minutes. We would like to see what you think about whales, whale-watching, and the environment. All information given is totally confidential, and your personal details will not be used or released to any sources

Nationality/State: ______________________ **Age**: □ 18-25 □ 26-40 □ 41-60 □ over 60
Sex: □ Male □ Female **Race/ethnicity:** __________________________________

1) How many times have you been whale watching? ___________________________

2) How have you gained most of your knowledge about whales? Please select only ONE answer.
□ TV/movies □ Books □ Internet □ Radio □ Newspapers or magazines
□ School
□ Family and friends □ Environmental organization □ my whale watch in Juneau

3) How satisfied were you with your whale watch experience in Juneau?
□ very satisfied □ satisfied □ neither satisfied nor dissatisfied □ dissatisfied □ very dissatisfied

4) Which of the following was the single most important factor in determining the quality of your whale watch experience? □ getting close to the whales □ being the only boat with the whales
□ being respectful of the whales □ being with the whales for a long time
□ seeing the whales do interesting behaviors like feed or leap □ boat size and number of passengers on board

5) How important is it *to you personally* to be able to see humpback whales in the wild?
□ very important □ somewhat important □ not important

6) After your whale watch in Juneau, how likely would you be to:
Go on another whale watch or marine ecotourism trip? □ very likely □ somewhat likely □ not likely
Join or donate to an environmental or conservation organization? □ very likely □ somewhat likely □ not likely
Tell your friends and family about what you learned? □ very likely □ somewhat likely □ not likely

7) Are you aware of any whale watch guidelines/regulations? □ Yes □ No
If yes, check the items that you think are part of the guidelines/regulations:
□ Maintaining a distance of at least 100 yards from the whales.
□ Staying with a whale for a maximum of 30 minutes.
□ Not encircling or trapping whales between boats, or boats and shore.
□ If approached by a whale, the engine should be put in neutral and allow the whale to pass.
□ Do not disrupt the normal behavior or prior activity of a whale.[6]

8) Which of the following environmental activities do you do? Check all that apply.
□ Recycle at home □ Recycle at work □ Conserve energy use at home □ Vegetarianism
□ Avoid cosmetics tested on animals □ Avoid using the car when possible □ Compost
□ Belong to an environmental or conservation organization □ Other __________________ □ None of the above

[6] Added to NOAA's Humpback Whale Approach Regulations in 2017

Please indicate your agreement or disagreement with the following statements about whale watching.

9) Observing whales from boats can have negative impacts on whales.

□ Strongly disagree □ Disagree □ Neither agree nor disagree □ Agree □ Strongly agree

10) Observing whales from boats can have positive impacts on people.

□ Strongly disagree □ Disagree □ Neither agree nor disagree □ Agree □ Strongly agree

11) Following whale watch guidelines and regulations is important for the protection of whales.

□ Strongly disagree □ Disagree □ Neither agree nor disagree □ Agree □ Strongly agree

Please indicate your agreement or disagreement with the following statements about nature. (circle the letters)

	Strongly Agree	Agree	No Opinion	Disagree	Strongly Disagree
12) The balance of nature is very delicate and easily upset	SA	A	N	D	SD
13) Humans must live in harmony with nature in order to survive	SA	A	N	D	SD
14) When humans interfere with nature it often produces disastrous results	SA	A	N	D	SD
15) Humans are destined to rule over the rest of nature	SA	A	N	D	SD
16) Plants and animals exist primarily to be used by humans	SA	A	N	D	SD
17) Humans have the right to modify the natural environment to suit their needs	SA	A	N	D	SD

Finally, we would like you to respond to a few statements about your relationships with others. How much is each statement TRUE or FALSE for you?

	Definitely True	Mostly True	Don't Know	Mostly False	Definitely False
18) I am always courteous even to people who are disagreeable.	1	2	3	4	5
19) There have been occasions when I took advantage of someone.	1	2	3	4	5
20) I sometimes try to get even rather than forgive and forget.	1	2	3	4	5
21) I sometimes feel resentful when I don't get my way.	1	2	3	4	5
22) No matter who I'm talking to, I'm always a good listener.	1	2	3	4	5

Please provide your email address to be entered to win a $50 Amazon gift card and to receive an invitation to participate in a follow-up survey.

____

Thank-you!

For information contact:

Master's Student Ali Schuler, University of Alaska Fairbanks, arschuler@alaska.edu
Principal Investigator Dr. Heidi Pearson, University of Alaska Southeast, hcpearson@alaska.edu, 907-796-6271

Appendix 2-C: "POST6M" survey sent on Survey Monkey website (www.surveymonkey.com) to participants that provided their email address in surveys before or immediately after their whale watch.

This survey is voluntary and will only take a couple of minutes. We would like to see what you think about whales, whale-watching, and the environment. All information given is totally confidential, and your personal details will not be used or released to any sources

Nationality/State: ______________________ **Age**: □ 18-25 □ 26-40 □ 41-60 □ over 60
Sex: □ Male □ Female **Race/ethnicity:** _________________________________

1) How many times have you been whale watching? __________________________

2) How have you gained most of your knowledge about whales? Please select only ONE answer.
□ TV/movies □ Books □ Internet □ Radio □ Newspapers or magazines
□ School
□ Family and friends □ Environmental organization □ my whale watch in Juneau

3) How satisfied were you with your whale watch experience in Juneau?
□ very satisfied □ satisfied □ neither satisfied nor dissatisfied □ dissatisfied □ very dissatisfied

4) Which of the following was the *single most important* factor in determining the quality of your whale watch experience in Juneau? □ getting close to the whales □ being the only boat with the whales
□ being respectful of the whales □ being with the whales for a long time
□ seeing the whales do interesting behaviors like feed or leap □ boat size and number of passengers on board

5) How important is it *to you personally* to be able to see humpback whales in the wild?
□ very important □ somewhat important □ not important

6) After your whale watch in Juneau, have you:

Been on another whale watch or marine ecotourism trip?	□ Yes	□ No
Joined or donated to an environmental or conservation organization?	□ Yes	□ No
Told your friends and family about what you learned?	□ Yes	□ No

7) Are you aware of any whale watch guidelines/regulations? □ Yes □ No
<u>If yes</u>, check the items that you think are part of the guidelines/regulations:
□ Maintaining a distance of at least 100 yards from the whales.
□ Staying with a whale for a maximum of 30 minutes.
□ Not encircling or trapping whales between boats, or boats and shore.
□ If approached by a whale, the engine should be put in neutral and allow the whale to pass.
□ Do not disrupt the normal behavior or prior activity of a whale.[7]

8) Which of the following environmental activities do you do? Check all that apply.
□ Recycle at home □ Recycle at work □ Conserve energy use at home □ Vegetarianism
□ Avoid cosmetics tested on animals □ Avoid using the car when possible □ Compost
□ Belong to an environmental or conservation organization □ Other _________________ □ None of the above

[7] Added to NOAA's Humpback Whale Approach Regulations in 2017

Please indicate your agreement or disagreement with the following statements about whale watching.

9) Observing whales from boats can have negative impacts on whales.
□ Strongly disagree □ Disagree □ Neither agree nor disagree □ Agree □ Strongly agree

10) Observing whales from boats can have positive impacts on people.
□ Strongly disagree □ Disagree □ Neither agree nor disagree □ Agree □ Strongly agree

11) Following whale watch guidelines and regulations is important for the protection of whales.
□ Strongly disagree □ Disagree □ Neither agree nor disagree □ Agree □ Strongly agree

Please indicate your agreement or disagreement with the following statements about nature. (circle the letters)

	Strongly Agree	Agree	No Opinion	Disagree	Strongly Disagree
12) The balance of nature is very delicate and easily upset	SA	A	N	D	SD
13) Humans must live in harmony with nature in order to survive	SA	A	N	D	SD
14) When humans interfere with nature it often produces disastrous results	SA	A	N	D	SD
15) Humans are destined to rule over the rest of nature	SA	A	N	D	SD
16) Plants and animals exist primarily to be used by humans	SA	A	N	D	SD
17) Humans have the right to modify the natural environment to suit their needs	SA	A	N	D	SD

Finally, we would like you to respond to a few statements about your relationships with others. How much is each statement TRUE or FALSE for you?

	Definitely True	Mostly True	Don't Know	Mostly False	Definitely False
18) I am always courteous even to people who are disagreeable.	1	2	3	4	5
19) There have been occasions when I took advantage of someone.	1	2	3	4	5
20) I sometimes try to get even rather than forgive and forget.	1	2	3	4	5
21) I sometimes feel resentful when I don't get my way.	1	2	3	4	5
22) No matter who I'm talking to, I'm always a good listener.	1	2	3	4	5